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MSS. intended for publication and books etc., intended for review should be sent to the responsible editor, Prof. J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*A LECTURE UPON ACETYLENE.**

A YEAR and a-half ago, if a chemist had been told that a new illuminating gas could be obtained from the evil-smelling product with which he was only too well acquainted in the laboratory, namely, the acetylene which forms whenever a Bunsen burner strikes down, he would have said that the idea was absurd. If a physicist had been told that the electric furnace was to be used to produce illuminating gas on a commercial scale he would have said it was quite impossible. But distinguished electricians were explaining that the telephone was impossible, while Graham Bell was inventing that instrument. So that scientific men will be well advised not to utter general opinions about the possibilities of the success of any new enterprise, and I shall endeavor to confine myself to the statement of certain facts and to the description of laboratory experiments, which constitute some new data which can be used to form an opinion regarding at least one side of this subject.

The chemistry of the manufacture of acetylene is very simple. Quicklime is reduced by carbon in an electric furnace to carbide of calcium, and enough carbon is taken not only to combine with the calcium to form carbide of calcium, but also to burn with the oxygen of the quicklime

* Delivered before the Society of Arts at Boston, January 23, 1896.

and to remove it as carbonic oxide. The process is represented by the equation: $CaO+3C=CaC_2+CO$. The carbide is obtained as a melted mass with crystalline structure, which when brought in contact with water is transformed to slacked lime, and to acetylene which is given off as a gas. The formula for this transformation is: $CaC_2+2H_2O=Ca(OH)_2+C_2H_2$. All the alkaline earths and alumina have been subjected to the same treatment, and it has been found that the carbides of barium, strontium and calcium have similar formulæ and give off acetylene when treated with water. The carbide of aluminum has the formula: Al_4C_3, and evolves marsh gas when treated with water. It may be added that a mixture of silica and carbon yields the carbide of silicon, SiC. The compound is formed when the two boches meet as vapors in the intense heat of the electric furnace and combine as a sublimate of beautiful crystals, now sold under the name of Carborudum. The powdered crystals have sharp cutting edges, hard enough to scratch rubies, and consequently make an excellent polishing and grinding material.

It is to be noticed that this formation of carbides affects the elements which make up by far the larger part of the earth's crust, so that from a geological as well as a chemical point of view these newly discovered transformations are of the utmost importance.

The reduction of these oxides to carbides is only possible at the high temperature of the electric furnace, and it is very interesting to note that at three very different stages of temperature we have such different conditions presiding over the union of the elements that each temperature corresponds to a new chemistry.

The temperature of the electric furnace, which has been estimated to be from 3,500° to 4,000° Cent., may be considered as intermediate between the sun's temperature, estimated by different physicists at 5,000° to 8,000°, and the temperatures of our smelting furnaces, which range from 1,200° to 1,500°. Now, in the sun's atmosphere, spectroscopic observations tell us that the elements exist uncombined, and we can even observe great masses of free oxygen in the presence of heated hydrogen and of metals so transformed in the properties which we are accustomed to recognize that they do not combine, but rise as vapors from the hottest part of the sun, condense and fall back in metallic clouds, which we know as sun spots. Here, then, is a temperature which is too hot for chemistry, if we define chemistry as the science of the combination of bodies.

The next temperature on a descending scale that we have access to is that of the electric furnace; here a partial combination only is possible; much of the oxygen remains free; carbon only burns to the nonoxide of carbon, and the carbides and not the oxides of the alkaline earths are the stable forms of combination.

Then, at a lower temperature the bright red heat of our smelting furnaces, the same carbides formed in the electric furnace, when exposed to free oxygen or to air, burn to oxides and to carbonic acid, and at a still lower temperature these two unite to form carbonates represented by the chalk and magnesian limestone which make so large a part of the earth's crust. Nature has so adjusted her processes that a small residue of oxygen remains, which, mixed with nitrogen, constitutes the vital air of our atmosphere. The carbides of aluminum and silicon burn in a similar way with oxygen, and the stable condition at any temperature lower than a bright-red heat is that of silicates and carbonates which make the chief strata of the earth.

The oxidation of carbides, which became possible when our globe cooled down to a red heat and solidified, has perhaps been a

superficial one, and the denser material below the crust may consist of carbides of the alkaline earths and carbides of the heavy metals like iron, and finally the metals themselves.

It is only within the last two years that experiments with the electric furnace have enabled us to study these new transformations at a high temperature, and have given us the means of estimating what must have been the primitive condition of the earth during long geological periods.

Berthelot, Moissan and others have pointed out that the evolution of marsh gas from volcanoes may be an indication of the existence of Plutonic remnants of carbides, dating from a period of higher temperature, and which we now know may give off gas when brought in contact with moisture.

The most important and orginal experiments made with the electric furnace have been published in the *Comptes Rendus* of the French Academy of Sciences by a young chemist, Henri Moissan, who had already distinguished himself by the discovery of fluorine. One of the first results which this new instrument gave in his hands was the artificial production of diamonds made by dissolving carbon in iron, and he then undertook a complete study of the formation of the carbides of the metals. Moissan's paper which interests us most directly was published on the 5th of March, 1894. It contains a full account of the formation of pure crystallized carbide of calcium and of its reactions with oxygen, sulphur, chlorine, etc., and a complete account of the formation of acetylene by the action of water upon the carbide, and nothing of scientific interest has since been added to the chemistry of acetylene, except some few experiments in European laboratories, notably upon its silver compounds.

French physicists have, however, made some very important measures of the thermic conditions which preside over the formation and decomposition of acetylene. They are a continuation of the admirable study of this singular gas, which was begun by Berthelot in 1859, and we shall find them of great value for explaining the properties which make acetylene useful or dangerous as an illuminant. The lecture will be confined strictly to the statement of facts which bear upon the proposed new gas industry, and no place can be given to the long-known laboratory processes for making acetylene, and to many experiments which display its general properties.

The idea of using this laboratory product upon a commercial scale originated in the United States, and the merit of it is due to Mr. T. L. Willson and Messrs. Dickerson and Suckert, who have secured patents; but it is important to insist upon the fact that they are not the discoverers of the crystalline carbide of calcium, nor of its transformation to acetylene and to hydrate of calcium. Moissan's publication of March 5, 1894, antedates their patents by many months, and describes completely the whole chemistry of the manufacture of acetylene.

No mention is made of Moissan's work in the reports published by the acetylene company in a lecture by Willson and Suckert before the Franklin Institute, and in a lecture before the London Society of Arts by Prof. Lewes. In these reports Mr. Willson is represented as having discovered the mode of formation of calcium carbide in the electric furnace by the reducing action of carbon upon refractory oxides. It is stated that the experiments were begun by Mr. Willson in 1888.

In such matters dates of discovery can only be established by publications, which in this case are to be found in the Patent Office reports. Mr. Willson took out four patents in 1889–1892 for electric smelting processes, and in several of them the use of carbon with refractory oxides is specified. The design seems to have been to make

aluminum and its alloys and perhaps other metals. No mention is made in the reports of carbide of calcium nor of acetylene. Dickerson and Suckert, December 31, 1894, nine months after Moissan's publication, patented a process for evolving and condensing acetylene made from the carbide of calcium. And June 18, 1895, is the date of the first patent by T. L. Willson in which the report specifies the production of carbide of calcium.

Many statements have been published concerning commercial aspects of the new enterprise, but it will suffice to say here that it has not yet reached a stage at which the vital question of the cost to the consumer of the carbide of calcium can be fixed by the quotation of a market price. Small quantities can be purchased for experimental purposes in New York at a price of $5 per 100 lbs. But the manufacture in the United States does not exceed one ton per diem and is carried on at Spray, in North Carolina, a somewhat inaccessible place, and no complete account of the process has yet appeared in the best-known scientific periodicals. The commercial carbide, unlike that made by Moissan, probably contains compounds of calcium with the ash of coke, but no complete analysis has been published. Some of the statements made about the number of cubic feet of acetylene are obviously inaccurate because the figures 5.89 to 6.35 cu. ft. acetylene per 1lb. carbide are as high or higher than could be obtained if the carbide contained no ash and were absolutely pure.

The accurate measure of the gas given off by the carbide is not easy and requires the construction of a special apparatus. The writer has examined a number of samples of commercial carbide, and found that 70 to 92 per cent. of the theoretical quantity of acetylene could be obtained from them. It appears that the product which can be made to the best advantage is one which contains 84.6 per cent. of pure carbide, and which gives 5 cu. ft. of gas per pound; or, for a ton of carbide, 10,000 cu. ft. acetylene, two-thirds saturated with moisture, and measured at 60° Fahr. and 30 inches barometer. Summer and winter variations of temperature, together with barometric variations, would cause a difference of more than 15 per cent. in the uncorrected measure of the gas, and gas measured in a mountainous region, without correction for the low barometer, would differ far more from the standard amount.

If the acetylene industry shall succeed, the cost of the carbide will have to be adjusted to the price that the consumer may be willing to pay for gas, and it is preferable to treat the subject from this side and to show, as far as laboratory experiments with materials at hand will permit, what will be the probable value to the consumer of acetylene gas.

A very simple experiment illustrates in a beautiful way the ease with which acetylene can be made from the carbide. Direct a small stream of water on a half-pound lump of carbide, ignite the gas and show that the more water is poured on, the more flame is obtained. Various forms of generators can be used for the gas. The simplest one is a bell glass floating on water and containing a few lumps of carbide in a sieve. As soon as the bell glass descends so that the sieve touches the water, a shower of fine sediment of slaked lime can be seen to separate from the carbide and fall to the bottom of the jar, while the gas generated soon causes the bell to rise and removes the carbide from contact with the water. Thus the apparatus can be made to work automatically, generating gas only as fast as it is used; but it is not fitted for permanent use, because the moisture from the water generates gas, even when the contact has ceased, and the bell gradually rises, so that after twenty-four hours gas would escape if it were not used during the interval.

It is in every way preferable to separate the generator and the gas holder, and such arrangements can easily be made automatic.

The acetylene company has patented a tank for generating the gas under sufficient pressure to liquify itself, and proposes to distribute liquid acetylene in cylinders under a pressure of 600 to 700 pounds to the inch; of this project more is to be said later.

It is certain that a company purchasing the carbide of calcium and using an existing gas plant could generate acetylene and distribute it through mains at a very small expense, and with little skilled labor, so that when a price for the carbide had been established by contract the cost of the gas could be easily estimated; let us see what price such a company could expect to obtain from a consumer.

VALUE OF ACETYLENE AS AN ILLUMINANT.

Suppose we take the case of a competition with the gas companies of a large town. At first sight it would seem fair to say we pay for the light gas gives, and if a new gas gives ten times more light we are willing to pay ten times more, particularly if it possesses any other advantages; our gas bill will remain the same.

Here we come upon ground where the facts can be tested by experiments. I have made a large number of measures of illuminating power and find that with a new burner particularly suited to it 5 cu. ft. of acetylene per hour will give 200 candle power; 5 cu. ft. of Boston gas will give a little more than 25 candle power. The Brookline gas is a little brighter. From this point of view alone then we can pay in Boston about $8 per 1,000 cu. ft. for acetylene when we pay $1 per 1,000 cu. ft. common gas. But will the gas bills remain the same at this ratio? More light will probably be used and the householder will be led into a more extravagant consumption, and he must decide what he is willing to pay for the new luxury. We must count then with the tastes of the consumer, and these can only be translated into money values after long trial of the new light in many houses.

Besides the question of meeting the desire of the consumer for more or less light is another, which must be taken into consideration depending upon his expertness in burning gas and the care he is willing to take in getting economical results.

No. 1. A Sugg-table fishtail burner is shown, burning just 5 cu. ft. per hour and giving the light of 25 candles. If more or less than 5 cu. ft. of gas is passed through it per hour it gives a lower efficiency and the light costs more. The law in Massachusetts, 1882, requires that the candle power should be tested with the most efficient burners, and I have used the best one for water gas. Coal gas would have given more candle power in an Argand burner. Burning gas economically is an art which is only understood by experts, and here again the habits of consumers disturb calculations; they are not usually willing to take the pains to get the best burners, as the following experiment will show.

No. 2 is a gas burner taken off the pipes in the Technology building and represents the average condition of burners in dwellings. About one-half the illuminating power of the gas is lost in this burner, and few people think of having the burners changed when they become inefficient.

If I put a globe over the burner, about half the light is absorbed, so that with a bad burner and with a milk-glass globe we pay about four times as much as need be for light; but the use of a globe is often necessary for comfort. The acetylene gas gives a different colored light, and I thought it might pass through the globe in larger proportion, but on measuring the candle power I found this was not the case. Perhaps a globe can be found that will especially suit acetylene light.

An important question then is to be answered before we can compare the lighting power of gas and acetylene. Is an acetylene light more tolerant of lack of care in the burners and of variations in the pressure than is the case with common gas? The most superficial observation shows that the two gases must be burnt in a very different way.

Gas burnt in an acetylene jet gives less than one-tenth of its true lighting power, and acetylene burnt in a common gas burner gives a yellow, smoky flame, and when turned down to a small flame it deposits soot on the jet, clogging the burner, if the opening consists of a straight slit. Even the very fine fishtail burners with a straight slit intended for oil gas suffer from this defect when the acetylene flame is turned down.

It appears then from the last experiments that the choice of burner and the mode of using it are very important factors in determining the value of any kind of illuminant, and hundreds of pages have been published on this subject with reference to oil and gas light, and it may be added that the results are not yet concordant.

Acetylene can not well be burnt in an Argand burner nor with the devices that succeed with petroleum lamps. A fishtail flame with a good exposure to the air must be used, and the best form of burner is that which throws the swiftest stream of acetylene into the air in the form of a very thin sheet.

A lava-tip burner has long been used for gas in which the opening is not a slit, but two small holes. The construction of these burners can be well shown by passing gas through two blowpipe jets, and when the two long jets of flame are made to impinge on each other at nearly a right angle they spread out into a fishtail form. Acetylene can be burnt in very small lava tip jets of this class, and gives about 30-candle power, but the light can not be turned low without losing its efficiency and smoking.

An experiment can easily be made which shows how large a quantity of air is required to render acetylene flames smokeless. Mix acetylene gas with measured quantities of air up to $1\frac{1}{2}$ volumes of air and burn the mixtures in a slit fishtail burner. It will be found that the acetylene does not diminish notably in illuminating power. Larger proportions of air begin to destroy the brilliancy of the flame. The same trials with common gas show that a very small proportion of air renders the flame less luminous. Suitable burners must be chosen in each case.

Acetylene can even be burnt mixed with one-third its volume of oxygen, giving a very brilliant flame. These experiments are only of practical value in indicating the kind of burner which should be chosen for acetylene. Another quality of the flame is very instructive from the same point of view. The acetylene flame clings to the burner in an extraordinary way, so that it is difficult to blow it out, and the luminous part of the fishtail flame almost touches the jet, while in a gas flame a large blue zone separates the luminous part from the jet. An instantaneous photograph shows well the character of the two flames and also their comparative actinic powers.*

By exploring the flame with a bit of platinum wire, it is easy to see, by the in-

* In the reproduction the gas flame appears relatively too bright.—ED.

tensity with which it glows, which is the hottest part, and also to recognize that the luminous part deposits soot on any cold object.

These experiments led to the idea of constructing a new form of burner for acetylene gas, in which the jets should be very fine and very perfect in form, and which should give the best possible access of air, and which should bring a very small section of metal in contact with the flame in order to avoid smoke and the deposit of soot.

The form eventually chosen is shown by the sketch. The burner is made of brass with nickel or steel tips. The extreme points in contact with the flame may be tipped with platinum or silver, but steel answers the purpose quite well. The most essential feature is that the tips should not be larger than $\frac{1}{16}$ inch in diameter. These burners abstract very little heat from the flame and consequently give more light than the usual form for the same candle power. They do not smoke with any height of flame. They burn acetylene advantageously with the 10- to 20-candle-power light to which we are accustomed. Lava tips are not well suited to such small flames, because the section in contact with the flame is about 20 times larger and abstracts so much heat that the metal setting for several inches in length becomes very hot. Loss of heat occasions loss of light.

It is particularly important in burning acetylene that a large supply of air should be drawn into the flame by the suction of the gas jets which issue from the two orifices of the burner. The steel jets described above provide for this by their perfection of form, as they are bored from their base and have the same proportions, which have been found to throw the swiftest stream under a given pressure with a hose nozzle.

It seems probable, in view of the careless use of burners in the ordinary consumption of gas, that one quality of acetylene will tell in its favor. With a suitable burner acetylene will tolerate greater variations of pressure than common gas. This point was determined by more than 100 measures of the candle power taken with the two gases burning under different pressures.

The smallness of the acetylene flame required to give off a brilliant light is a point in its favor, allowing the use of a great variety of globes and shades for tempering or reflecting the light.

The same quality will be found of advantage whan a strong light is to be concentrated as nearly as possible at the focus of a mirror or of a lens, as in locomotive headlights or in lanterns for projections.

It was hoped that the quantity of light given off by duplex or triplex acetylene flames would show a particularly economical consumption, but the results of measures of the candle power of such flames with or without chimneys were disappointing. It appears that defect of air supply with such flames more than counterbalances the effect of the heat which one flame communicates to the other.

It might be desirable to use the existing gas plants and to deliver, as heretofore, a gas of 20-candle power suitable for heating or lighting. Such a project seemed very easy of fulfilment, since it was at first supposed that acetylene could be used to enrich common gas, and in that case no changes would be required in the mode of distribution nor in the form of burners. Experiments have shown that it can be employed to enrich coal gas, but that water gas, which is so largely used in this country, cannot be enriched by acetylene. Water gas has little

illuminating power and requires to be enriched by passing petroleum oil into the retorts during the manufacture, and it is only when water gas has already been brought up to a certain candle power that acetylene gas can be mixed with it without losing its effectiveness as an illuminant; so that it cannot be used as a substitute for petroleum to enrich crude water gas.

There is no apparent reason *a priori* why an admixture of a combustible gas should deprive acetylene of its illuminating power, and it is interesting to examine separately the effect of each one of the constituents of water gas to see which one has this property.

Brookline gas, besides 16% of illuminants derived from oil, contains equal quantities (about 26%) of hydrogen, marsh gas and carbonic oxide. If each one of these is burnt separately with acetylene it appears immediately that it is the carbonic oxide which renders the acetylene flame non-luminous. Ammonia also has a singular effect upon common gas and upon acetylene, nearly destroying the lighting power and giving a beautiful faint purple flame with curious marked fringes, but ordinarily only traces of ammonia are contained in gas. Nitrogen has much less effect than ammonia or carbonic oxide in destroying the illuminating power of acetylene.

The preceding statements tend to show that a summary of the qualities of acetylene gas, as compared with common gas, must comprise other data beside the measures of candle power, and I have endeavored to point out some of the peculiar properties of the new light which are advantageous. The price and the taste of the consumers must decide the question of competition.

The gas of small towns is usually poorer in quality and higher in price than in large towns, and perhaps the opportunities for the introduction of acetylene are greatest in this direction. Consumers may be willing to pay $15 per thousand for acetylene gas where they pay $1.50 for 16-candle water gas or coal gas.

I should expect to see it first introduced to replace the very expensive oil gas used in railroad carriages, and also for special purposes where great brilliancy and concentration are required, like the head lights of locomotives. For such purposes the Welsbach light cannot be used, because it is destroyed by jarring. The adherence of the flame to the burner is an advantage for railroad use, making the flame hard to blow out. For shop-window illumination the Welsbach light, which is very much cheaper than gas burnt in any other way, seems to be beyond the reach of competition; and the Auer burner, which is similar, is now used for street lighting in Paris, and these incandescent lights work well wherever the light is not shaken, and where the disagreeable green tint is not an objection.

For country houses acetylene light seems well fitted and might replace the very bad illumination of gasolene light.

Much skill and special knowledge are required to run gas works, while the making of acetylene from the carbide or its distribution as a liquid is so simple that acetylene stations could be established in many villages too small to make gas works pay. Moreover the winter consumption of gas is two or three times that of the summer, when the gas plant lies idle in part. With acetylene there is an advantage in this direction, because the value of the plant would be much less.

The whiteness of acetylene light renders it useful for displaying or sorting colors, and some experiments made with Mr. C. R. Walker show that, for photographic purposes, when equal quantities of acetylene light and of water-gas light, measured by candle power, are compared, the acetylene light has two and one-half times the actinic value of the other.

POISONOUS QUALITIES OF GAS AND ACETYLENE.

Continuing the comparison of common gas and acetylene, let us see how the case stands from a sanitary point of view. We see reports in the newspapers of deaths and attacks of illness from gas poisoning, the dropping out during the night of the core of a gas cock or a break in a pipe, would often be an accident fatal for the inmate of a small, close bed chamber. Recently persons have been poisoned by a defect in the gas main outside of their houses. Workmen are frequently made ill by a leak in the gas mains while working in a trench, but the officers of the gas companies state that such accidents are very seldom fatal.

There is no question then about the poisonous qualities of common gas and particularly of water gas. Is the new illuminant likely to be less dangerous?

The poisonous constituent of common gas is carbonic oxide. London gas contains 3.2 to 7%; Paris gas 7%; Berlin gas 8%; Boston gas 26%.

Formerly there was a legal limit of 10%, which is now removed, and the introduction of water gas has raised the percentage to this very high and dangerous amount.

Carbonic oxide is not irritating or corrosive, and it seems strange that a compound so nearly allied to carbonic acid, which is innocuous, should act as a rapid poison.

The mode of action is this: Carbonic oxide is absorbed and retained by the blood in a way quite different from other gases. It combines with the red corpuscles, and the compound shows under the spectroscope special absorption bands, which make the recognition of its presence easy.

Blood which has taken up a certain quantity of carbonic oxide no longer is capable of taking up oxygen in the lungs and conveying it through the circulation, and death by suffocation ensues, just as if there were not enough oxygen to breathe.

The blood is so sensitive to carbonic oxide that so little as 0.03 % in the air can be shown (Bull. Soc. chem. (6) 663) when a solution of blood is brought thoroughly in contact with a mixture containing carbonic oxide.

The best way to bring a liquid in contact with a large body of air or gas would be to have it circulate by means of minute canals, using a pump to keep the current in motion through the cell walls of a sponge, while the air was continually changed by squeezing and relaxing the sponge. We can find such a little machine in a very perfect form in the body of a small animal, the veins and arteries constituting the canals, the pump being represented by the heart, and the sponge by the lungs.

If we sacrifice a mouse as a martyr to science and enclose him in a tight box containing air with a known percentage of carbonic oxide, and kill him after 3 or 4 hours, we can detect the carbonic oxide absorbed by his blood.

A similar method is best suited to discovering whether acetylene is absorbed by the blood. We might suspect that this would be the case since the two gases have in common the peculiar property of being absorbable by solutions of subchloride of copper.

Grehant (Comptes Rendus 1895, II., 565) made a careful comparison of carbonic oxide and acetylene in respect to their poisonous qualities upon dogs. He took care to have 20% oxygen always in his mixtures, so as to give it the vital quality of air and not to kill his animals by suffocation. He added 1% carbonic oxide (*i. e.*, enough Paris gas (containing 7% CO) to give 1% carbonic oxide). After 3 minutes the animal suffered; after 10 minutes the dog was very sick and his blood contained 27 volumes per 100 of carbonic oxide. The dog would have soon died if the experiment had been prolonged.

In a mixture containing 20% oxygen and

20% acetylene a dog breathed without inconvenience for 35 minutes. His blood contained 10% acetylene, less than $\frac{1}{50}$ the rate of absorption of carbonic oxide and not a larger percentage of acetylene than would have been absorbed by water. The mixture contained much more acetylene than could ever get into the air of a room, and in fact in a dwelling house a much smaller quantity would produce an explosion.

A dog was killed by breathing 40% acetylene and 20% oxygen in 51 minutes; another in about 30 minutes by 80% acetylene and 20% oxygen. A guinea pig was *not* killed in 39 minutes by the same mixture.

L. Brociner (Comptes Rendus 1895, II., 773) had made similar experiments in 1887, and concluded that acetylene was not poisonous. It is not more absorbed by blood than by water. It has *no* specific action on blood. Sulphide of ammonium reduces such blood normally. It has no special absorption band.

Berthelot and Claude Bernard 30 years ago found acetylene not poisonous.

Moissan (Comptes Rendus, 1895, II, 566) says pure acetylene only has an ætheric agreeable odor.

Bistrow and Liebreich in 1868 (Ber. I., 220) pronounced acetylene poisonous, but this opinion is contrary to that of Berthelot and of Claude Bernard, and Berthelot has recently stated anew that pure acetylene is not poisonous, and has pointed out that the old method of preparation of acetylene by means of the acetylide of copper may contaminate the gas with prussic acid (Comptes Rendus, 1895, II., 566). It may be concluded then on the best authority that *pure* acetylene is not poisonous.

The smell of freshly prepared acetylene made with commercial carbide of calcium would lead one to suspect that the gas contained phosphoretted hydrogen and Wellgerodt (Ber. 1895, 2107, 2115) detected its presence in acetylene by passing the gas through nitrate of silver solution. I also got by another method a good molybdate test for phosphoric acid, before I knew of the above publication.

The phosphorus is probably derived from phosphates in the quicklime and in the ash of the coke used for making the carbide of calcium. Moissan used a pure carbon obtained by charring sugar, and his carbide gave pure acetylene free from disagreeable odor. The previous statements that acetylene is innocuous may only apply to pure acetylene, and it is important then to make a special examination of commercial acetylene to see if it contains dangerous constituents. I have only found one statement on this subject contained in the *Electrical Engineer*, New York, November 13, 1895, p. 469.

Dr. W. H. Birchmore says that 1 cu. ft. of acetylene in 10,000 cu. ft. of air produces headache in twenty minutes, and that so small a quantity of acetylene is not perceptible to smell.

I have frequently breathed air containing enough acetylene to be very plainly noticeable from its smell, and have not suffered the slightest inconvenience. It seems probable that individuals differ greatly in their susceptibility to poisons of the class to which phosphoretted hydrogen belongs. It is also quite possible that other poisonous gases in very small quantity may constitute impurities of acetylene. Dr. Birchmore performed a single experiment upon an animal and states that one part of acetylene in 10,000 parts of air killed a guinea pig in six hours; sickness came on in ten miutes. The blood lost its power of absorbing oxygen, as in a case of poisoning by cyanhydric acid. He did not examine the blood for acetylene. Experiments of this kind should be repeated by competent physiologists, and the blood should be carefully tested. It is quite certain that in this case the death was

caused by some other body present and not by the pure acetylene.

If it is found that phosphoretted hydrogen or some similar impurity is present in dangerous quantity, they can probably be removed by a proper treatment of the gas.

Arsenuretted hydrogen might also be present, but I have failed to find any trace of it in commercial acetylene.

It has been said that acetylene gas could never act as a poison, because an escape from a leaky pipe would attract the attention of a person, even while asleep, by its irritating action upon the throat, producing coughing. The statement is contrary to all my observations.

Further experiments upon this subject are required, but the evidence already accumulated seems to be favorable to acetylene as compared with water gas, and if the new illuminant can be made for a reasonable price and can be quite freed from poisonous impurities it should become a formidable competitor with water gas. On the other side, however, we shall find that the danger from explosion will call for special precautions in the use of acetylene gas.

DANGER IN USE OF LIQUIFIED ACETYLENE.

There will be an evident advantage, if acetylene gas lighting succeeds, to begin by introducing it without putting down mains and setting down generating houses; this can be done by supplying customers with liquified gas. A cylinder holding say 1,000 cu. ft. gas compressed in a space of less than 2 cu. ft. can be attached to the gas pipes of a house in place of a meter.

This new gas service is, however, not so simple as would at first appear. Two cylinders must be used at once, or at least a second one must be brought before the first is exhausted to make the supply continuous, otherwise we should have the disagreeable surprise of finding the gas extinguished. A gauge on the cylinders must be watched to see when No. 1 must be cut off and No. 2 turned on. Neglect in care of this will cause extinction of the gas and discredit of the system. The gas companies have accustomed us to a constant supply through mains at an even pressure and have set a high standard of convenience.

The cylinders contain gas at a pressure of 6 to 700 lbs. A reducing valve, always kept in order, must reduce this pressure to 1 oz.=2 inches water. The Pintch valve employed on railroad lines is used, but we must ask the question: Will it always keep in order with the care it would get in a private house or tenement house? Then an escape valve is required in case a fault of the Pintch valve throws the whole pressure on the pipes. A mercury seal would answer to empty the gas into the air, and it could be counted on to work satisfactorily, but the gas would be lost each time that the valves got out of order.

All this apparatus makes the use of liquified acetylene somewhat complicated, and in addition to this disadvantage it would present a serious danger in case of fire. The cylinders when strongly heated would be liable to explosion, and it is proposed to guard against this danger by employing a mercury seal to empty them when the pressure exceeds safe limits. This arrangement, even supposing that it always performed its office during a fire, would be open to a serious objection, for if the fire took place in a large building in a town containing, say, 10 cylinders with 5,000 cu. ft. of gas in the 10, this quantity of gas thrown in the air would make an explosive mixture with 20 times its volume of air, or about 100,000 cu. ft. in all, and whether disengaged on the roof or in the street would expose the firemen to a new danger.

If we add to the small annoyances arising from the care of a gas supply which is not constant like that of gas delivered in mains, the danger of explosion of a cylinder

weakened by rust or neglect, the danger in case of fire and the very doubtful economy of the systems, the summary seems unfavorable to use of liquified acetylene, except in places where sufficient space can be had to isolate the cylinders as gasoline tanks are now isolated.

It will be seen later that these cylinders may be exposed to a special danger, although a very improbable one, from the explosive decomposition of acetylene under the impulse of a certain kind of shock.

THE TEMPERATURE OF THE ACETYLENE FLAME.

When we compare acetylene and common gas illumination from the point of view of the products of combustion which vitiate the air of a room, or of the heat which is given off, the conclusions are very favorable to acetylene lighting, because ten times as much common gas has to be burnt to obtain the same amount of light as would be given by a unit measure of acetylene. The heating effect, however, is not in the ratio of ten to one. Ten cu. ft. of Boston gas give 2.42 times as much heat as 1 cu. ft. of acetylene.

Prof. Lewes* has calculated the amount of carbonic acid given off by different illuminants, and finds, for an equal amount of light, that coal gas gives off six times as much as acetylene, and he estimates that the heat from acetylene would not be much greater than from the ordinary incandescent lamp.

The true relations are for the same amount of light: Heat from incandescent light, 1; acetylene, 3; water gas, 9.

Prof. Lewes says, in the same connection: "The flame of acetylene, in spite of its illuminating value, is a distinctly cool flame, and in experiments which I have made by means of the Lechatelier thermo-couple, the highest temperature in any part of the flame is a trace under 1,000° Cent. While coal gas, burning in the same way in a flat-flame burner, the temperature rises as high as 1,360 Cent."

It is not an advantage, but a disadvantage, that the fishtail acetylene flame should be cool. Its temperature is lowered by the excessive contact with air required for complete combustion, and, if the flame could be made hotter, more light could be obtained for the same quantity of heat. It is scarcely necessary to add that the temperature of a flame has nothing to do with the heat of combustion. Phosphorus or sodium can be burnt at the ordinary temperature, or at a red heat, and the heat of combustion is the same at either temperature, provided the products of combustion are the same.

Lechatelier,* one of the best authorities upon such a subject, does not appear to have measured the temperature of the acetylene flame with his pyrometer, and, in fact, such measurements are very difficult; but he has calculated that acetylene, burned with air, may reach a temperature of 2100° to 2400° Centigrade, and, burned with oxygen, 4000°.

It is easy to melt platinum in a common air blowpipe flame fed with acetylene, but the platinum appears to first form a carbide.

Acetylene, notwithstanding its high cost, may find a restricted use in the laboratory in air or oxygen blast furnaces; it will undoubtedly give a higher temperature than gas or hydrogen.

The preceding description has continually held in view the utilitarian side of the question, and it has been thought simpler to enumerate the items in favor of the economical use of acetylene as compared with gas and not to extend the comparison to other forms of illumination, but the following table mostly taken from the most recent book† on the subject gives the means of

* A paper read before the Society of Arts, London.

* Comptes Rendus, December 30, 1895.

† Julius Swoboda: Petroleum Industrie. Tübingen, 1895.

comparing other modes of lighting. It is to be remarked that authorities differ widely in their estimates, and the cost of gas and electric lighting varies greatly with the locality. Electricity is particularly advantageous when it can be put to other uses during a part of the day.

100 CANDLE LIGHT DURING 1 HOUR.

	Quantity.	Cost. Cents.	Heat of combustion. Kilograms of water 1 degree.
Arc light.	0.09—0.25E	1—2.5	57—158c
Incandescent lamp	0.46—0.85E	3—5	290—536c
Boston gas, $1 per 1000	20 cu. ft.	2.0	3380c
Acetylene, $10 per 1000	2½ to 3 cu. ft.	2.5—3	1000-1200c
Petroleum lamp	0.62 lb.-1.0 lb.	2.0	3360c
Carcel oil lamp	0. 9 lb.	8.0	4200c
Paraffine candle	1. 7 lb.	28.0	9200c
Spermaceti candle	1. 7 lb.	54 0	7960c
Wax candle	1. 7 lb.	61.0	8940c
Stearine candle	2. 0 lb.	33.0	9700c
Tallow candle	2. 2 lb.	32.0	

THE CHEMICAL PROPERTIES OF ACETYLENE.

A series of very simple experiments will illustrate the most important properties of acetylene.

To compare its density and its explosive force with those of common gas take two lamp chimneys closed at the top and bottom with corks, and each fitted with an inlet tube at the bottom and with a large brass tube at the top. Fill one with gas and the other with acetylene and light both gases at the upper tube; then remove the rubber tubes from the inlet tubes. The flames will continue to burn at the upper orifice, because each gas rises, floating on a layer of air, which rushes in from below, and the relative densities of the gases may be estimated from the rapidity with which each flows out. The common gas flows out more rapidly and burns with a higher flame than the acetylene, because it is lighter: (density of Boston gas=0.607; density of acetylene =0.91). At the last the flame strikes down into the small residue of each gas, which has become mixed with air in the lamp chimneys, and a slight explosion takes place, which is notably stronger with acetylene than with gas. The greater density of acetylene explains partly why it should have more illuminating power than common gas, since a cubic foot contains more material. As our object is only to examine the properties of acetylene which have a bearing upon its illuminating power, one test of its chemical activity will suffice. Set free a small quantity of hypochlorous acid gas in a tall glass jar and plunge into it a tube from which a stream of acetylene is issuing, this latter will immediately take fire from the great heat evolved by its chemical action upon the hypochlorous acid. If common gas, or almost any other gas, were subjected to the same test no flame would result.

Acetylene forms peculiar salts with copper, silver and mercury; and these when dry decompose explosively when subjected to a shock or to the action of heat. The silver compound can even be exploded under water and is more dangerous than fulminate of silver.

EXPLOSIVENESS OF ACETYLENE.

What we have learned concerning the extreme chemical activity of acetylene leads us to expect that it would form more readily than other gases an explosive mixture with air, and this proves to be the case.

Experiments using a piece of two-inch gas pipe as a cannon show that 5–6% of acetylene mixed with air forms an explosive mixture; 10–12% of water gas is required to explode with air.

The heat abstracted by the walls of the iron tube prevents the mixture from obtaining its limit of explosiveness, and a still smaller percentage of either gas mixed with the air of a room would explode. Lechatelier (Comptes Rendus, 1895, II., 1145) gives 2.8% of acetylene mixed with air as the explosive limit, and it is to be noticed that in a dwelling house the danger from

explosion is enhanced by the inequality of such mixtures. A flame spreading from a spot rich in gas would propagate itself explosively through a mixture very poor in gas.

The danger is enhanced in the case of acetylene by the low temperature at which it takes fire, 480° Cent. Most other gases must be treated to about 600° to take fire and marsh gas, the fire damp of mines, fortunately requires a much higher temperature to ignite, so that a spark from flint and steel does not suffice to cause an explosion. Acetylene burns with greatest increase of volume when the products are carbonic oxide and hydrogen. The violence of combination of acetylene with oxygen can be well shown by igniting equal volumes of the two gases. A quantity equal to 3–4 grains makes a far louder report than the same weight of powder or of nitro-glycerine.

The dangerous properties shown by acetylene need not condemn it, but particular care must be taken to prevent leakage if acetylene gas comes into use; fortunately small pipes can be used and the gas contains no ammonia, which, in common gas, destroys the grease on the stopcocks and promotes leakage.

If instead of igniting a mixture of air and acetylene, the latter alone is passed through a glass tube heated to dull redness, at first a slight change takes place, and liquid benzene and other products condense in the colder parts of the tube; at a little higher temperature the change goes further—carbon is deposited and hydrogen is set free. If the interior of the tube is carefully watched it will be seen that the decomposition takes place with a dull red flame, as if the acetylene were burning with an insufficient supply of air. No air, however, is in the tube; there is no combustion in the ordinary use of the word, and yet we have in the flame evidence of a sudden disengagement of heat. Here we approach the solution of the problem, regarding the extraordinary chemical activity of acetylene. Acetylene has a supply of heat stored up, which it gives off, whenever it is decomposed spontaneously, burnt in air, or excited by any radical chemical change. The sudden evolution of heat manifests itself as light, quickens combustion and promotes all chemical action.

The exact quantity of heat absorbed and stored up by acetylene, when it is formed by the union of carbon and hydrogen, can be best measured by two experiments. Firstly, burn exactly one cubic foot of acetylene in a calorimetric apparatus, which is merely a device for heating a given weight of water without loss of heat, and find that nearly nine pounds of water can be heated from its freezing to its boiling point. Or, if we take the thermal unit in more general use we find that 407 kilograms of water gain one degree Centigrade in temperature from the heat given off by burning one cubic foot of acetylene gas, measured at 0° Cent. and 76 cm. barometer.

Secondly, take exactly the weights of carbon and hydrogen which correspond to the weight of one cubic foot of acetylene and burn them in the same way under a weighed quantity of water. We shall find that according as we take pure amorphous carbon or diamonds we get a somewhat different quantity of heat. With amorphous carbon and hydrogen 336.5 kilograms of water are raised 1 degree Cent. in temperature. The difference of heating power then between acetylene gas and the same weight of carbon and hydrogen is 71 heat units. The surplus energy stored up in the acetylene and set free when it is burnt becomes evident and is measured, when we find that the acetylene arrangement or combination of carbon and hydrogen atoms is capable of making the elements do more work, that is to heat 71 kilograms more water than when

the same elements are free in the state of amorphous carbon and of hydrogen gas.

When the carbon from carbide of calcium and hydrogen from water combine to make acetylene heat is utilized in changing the carbon from the solid and the hydrogen from the liquid form to the form of a gas. Heat is absorbed in this process which imparts a new energy of motion to the atoms, in the same way that heating water separates the particles to two thousand times wider distances from each other and gives them the energy of motion which is apparent in steam. In this case we can measure the amount of heat required for this work and which is absorbed while it takes place. Unfortunately we can not get similar measures with carbon vapor and solid carbon, and we can only measure a total absorption of heat during the generation of acetylene, and we suppose that the total, 71 heat units, may be made up by the absorption of a larger amount of heat in order to change amorphous carbon to the gaseous state, from which must be deducted the heat which is given out when two carbon and two hydrogen atoms combine to make C_2H_2. Benzene which has exactly the same percentage of carbon and hydrogen, but combined into quite a different chemical group shows that more energy has been expended in bringing about its chemical arrangement. The signs which attest this are greater stability, smaller chemical activity, and above all the fact that when benzene is burnt it gives off much less heat than the same weight of acetylene does, and in fact only 4 heat units more than the same weight of carbon and of hydrogen.

It has seemed necessary to explain fully how quantities of energy, which can usually be measured in terms of heat, preside over the making of different chemical compounds, and how the dormant heat can be made active again when the compounds are excited to chemical change, and how each one is stamped as with a birth mark by its special heat value.

This peculiar stamp set upon acetylene is at the same time a token of valuable and also of dangerous qualities. Heat is added to the heat of combustion and brings about more sudden changes and places acetylene with the class of bodies known as fulminates. These are distinguished from explosives like gunpowder by their capability of suddenly evolving stored-up heat, which causes a great expansion of gaseous products. Berthelot has calculated that fulminate of silver develops a pressure of 600,000 lbs to the square inch in the incredibly short time of one-thirty-millionth of a second. The acetylide of silver has similar properties, and the lightest shock suffices to explode it. It occurred to Berthelot to see whether acetylene gas might not decompose spontaneously into carbon and hydrogen with explosive suddenness. We have seen that it decomposes into these products, *but without explosion*, when strongly heated, and only in one way could it be made to decompose explosively. Berthelot succeeded in detonating pure acetylene by subjecting it to the shock of fulminate of silver.

The danger seems very slight that acetylide of copper or some other metal may form in an acetylene gas-holder, and when exploded by friction or heat cause the whole mass of gas or liquid acetylene to explode. The subject, however, is worthy of further study.

As was said in the beginning, the problems which are suggested by this new industry touch on all sides upon some of the most important of the recent discoveries in chemistry and physics, and the ease with which acetylene can be obtained opens the door to many new experiments. Such questions, for instance, as the use of acetylene in gas engines, under special conditions, where the high price would not be prohibitive, would offer a very interesting study. It

does not seem impossible that a gas so active and so easily stored might be exploded with air in a pneumatic gun to give an additional impulse to the projectile.

The laboratory experiments which have been described may perhaps serve as a guide in some directions to manufacturers, but they cannot settle the commercial details upon which the success of the new enterprise depends. Much further study and tests upon a larger scale, with the improvements suggested by prolonged trial, can alone decide whether the new illuminant is destined to supplant older industries built up slowly and surely by the persistent efforts of hard-working and skillful men.

J. M. CRAFTS.
MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

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*NOTES ON THE CERRILLOS COAL FIELD.**

DURING August, 1895, the writer revisited the Placer, or Cerrillos, coal field of New Mexico, which is about 25 miles south from Santa Fé. The field is small, apparently a detached portion of the Laramie area extending far southward within the Rio Grande region.

The district of especial interest is a strip lying south from Cerrillos and Waldo, stations on the Santa Fé railroad. It is less than two miles wide and reaches southward to a little more than five miles from the railroad; but evidently all of the workable coal beds are shown, and the transition from bituminous to anthracite is exhibited very satisfactorily. The mines are on Coal cañon, which extends from the Placer, or Ortiz mountains, at the south, to Waldo, at the north, somewhat more than six miles.

The Ortiz mountains are largely trachytic; from them there extend northward two plates, each one about 200 feet thick, which lie between Laramie beds and follow their dip very closely. The upper plate covers the area east from Coal cañon and is now the surface rock, the overlying beds having been removed. It extends northward to somewhat less than two miles south of Waldo, terminating abruptly at the lower end of Madrid, where are the offices of the Cerrillos Coal Company. The lower plate, about 400 feet feet below the upper, does not come to the surface on Coal cañon, but it was pierced in a boring on the mesa immediately west and it crops in an arroyo within a few rods further west. Several dikes extend upwards from this plate, one, very large, seen west from Coal cañon, which must have been connected with the upper plate, as it rises very high above the mesa; a second, seen in Coal cañon, not more than 10 or 12 feet wide does not reach the upper plate; a third, very narrow, found in the same cañon at a mile and a half above Madrid, passes distinctly into the upper plate. Prof. Kemp examined the specimens from several exposures and recognized the close relation in composition throughout.

The stratified rocks within this strip belong to the Laramic and the exposed section is somewhat more than 1,000 feet thick. They resemble those of the same age in the Trinidad coal field, but shale is present in greater proportion. Limestone is apparently wholly absent and the sandstones are unusually non-fossiliferous. The coal beds are numerous, but most of them are very thin and several are not persistent in all of the sections.

The only coal beds of interest here are those in the interval between the trachyte plates; they are

White Ash coal bed	2′6″ to 7′
Interval	70′
Coking coal bed	1′ to 2′6″
Interval	80′
Cook-White coal bed	3′
Interval about	150′
Waldo coal bed	4′

*Abstract of paper read before N. Y. Academy of Sciences, January 20, 1896.

The *White Ash bed* is not more than 15 feet below the upper plate and the *Waldo bed*, as found in the bore hole, not more than 10 feet above the lower plate of trachyte.

The *White Ash* has been mined at many pits along Coal cañon for a distance of nearly three miles, beginning at about a mile and a half from Waldo. It is the important bed of the region and the only one now mined. Four pits, two of which are now in operation, show the bed. At the old Boyle mine, about a mile and a half above Madrid, the coal is a hard, dry anthracite, slipped and jointed throughout; some portions closely resemble the graphitoid anthracite of Rhode Island.

The Lucas mine at Madrid was idle when visited, but work had been stopped for only a short time. The southerly levels of this mine yield an anthracite of excellent quality, equal in appearance and composition to the average anthracite of Pennsylvania; but a rapid change is shown in the northerly levels. Jointing becomes annoying at a little distance from the slope, and the coal is wasted in the breaker; within 350 feet evidences of great pressure and disturbance accumulate, and the coal is laminated like that from some Vespertine mines of southwest Virginia, with the polished surfaces, often curved, frequently not more than one-fourth of an inch apart. This, however, is still anthracite, and work was stopped in these northerly levels only because of great waste in breaking.

The Cunningham mine, at the lower end of Madrid, entered a tender coal at the crop; the slope was pushed 1,100 feet, but no anthracite was found. The coal burns with flame.

The White Ash mine, about half a mile north from the Lucas, is the important pit. At one time trains might be seen coming from its slope made up of cars carrying, some of them anthracite, others the tender semi-bituminous, and others still the rich bituminous coal which has given this mine its reputation. The bituminous coal, containing 39 per cent. of volatile combustible, is obtained from the northerly levels, but the southerly levels yield for the most part what is called tender coal. The latter is dull, very tender, and much of it has an almost cone-in-cone structure. It is reached in the southerly levels at varying distances from the slope. The passage from bituminous into anthracite through this tender coal is shown in the sixth level southerly where tender coal was reached at 125 feet from the slope and anthracite at 450 feet. The passage is gradual. The anthracite makes its appearance at the bottom and thickens gradually, crushed coal being replaced by laminated and that by the harder almost homogeneous coal, the change being completed within 50 feet.

The *Coking bed* was worked some years ago at about two miles above Madrid, where its coal was coked in ricks.

The *Cook-White* is no longer mined, but it has been opened at many places along Coal cañon, and the changes in character of the coal are clearly shown. Above Madrid fragments on the old dumps show that the coal is anthracitic; a pit at the lower end of Madrid, almost midway between the Cunningham and White Ash mines, shows a tender coal which bears some resemblance to that from Pocahontas, in Virginia; analysis shows that it contains about 30 per cent. of volatile, which is about what should be expected, if its changes are similar to those of the *White Ash*.

The *Waldo bed* is not reached in the upper part of Coal cañon, but it has been mined extensively further down. The only interest it has here is its existence in the bore hole west from Coal cañon, where it is not more than 10 feet above the lower plate of trachyte and shows no evidence of any metamorphism whatever.

Long ago Newberry, and afterwards Stevenson, regarded the coal as metamorphosed by heat from a great dike of eruptive rock following the northerly side of the Placer (now Ortiz) mountain. This, which then was but a suggestion, is sufficiently clear as an explanation now. As the center of eruption was in the Ortiz mountains the metamorphism should be most notable near those mountains. That is distinctly the condition, for, at the most southerly point showing the *White Ash bed* well, the anthracite is very hard; but the change is less toward the north until normal coal is reached in the White Ash mine below Madrid. The gradation is equally clear in the *Cook-White bed*; but the small bed between the main seams appears to contradict the hypothesis, as it is decidedly bituminous at half a mile above the pit, where the *White Ash bed* yields the hardest anthracite observed. This condition is easily explained by the fact that the small bed is not continuous, being broken by clay seams several feet wide, which sometimes cut out all of the coal; these seams would prevent the passage of heat from one portion to another.

The conditions at several localities show that mere proximity to the mass of eruptive rock was insufficient to produce change. The lower plate of trachyte is but 10 feet below the *Waldo coal bed* in the bore-hole west from Coal cañon, but, though 200 feet thick, it had no appreciable effect upon the coal. The interval between the *White Ash bed* and the upper plate of trachyte shows insignificant variations along Coal cañon, and it must be approximately the same in the newer parts of the White Ash mine; yet in the Lucas mine and at all localities south from it the coal is anthracitic; whereas at all points north from it to the border of eruptive rock one finds only transition coal. It seems clear that direct contact is necessary to produce change.

Prof. J. F. Kemp describes the eruptive rock as a trachyte closely allied to andesyte. Its outflow then was early, possibly at the time of the Laramide elevation, when great outpourings of andesyte occurred in Colorado, Utah, Wyoming and Montana. The coal was completely formed prior to this elevation, prior to any disturbance, there being not only no evidence of pulpiness, but every evidence that the coal was thoroughly hard. It was crushed into minute fragments, slicken-sided, like the Utica shales of Franklin county, Pa., or laminated and rolled into leaves, like the Vespertine coals of southwestern Virginia. The process of conversation was complete before disturbance not merely in the lowest beds, but also in the *White Ash bed*, at nearly 900 feet above the bottom of the Laramie.

JOHN J. STEVENSON.

THE RÖNTGEN PHENOMENA.

A FEW EARLY RESULTS OBTAINED AT THE UNIVERSITY OF PENNSYLVANIA.

THE first attempt here to repeat Röntgen's experiments was made on Wednesday, January 22d, but without success, owing to the impression obtained from early accounts of experiments abroad that two induction coils were necessary. As a matter of fact, one coil giving a four-inch spark through air is quite powerful enough to produce most of the results that have yet been obtained. The average current through the primary is about three amperes with an E. M. F. of twelve volts. Our tube is a beautiful large pear-shaped one, admirably adapted for the purpose. It is about 27 cm. long, and 11 cm. in diameter at the largest end.

Fig. 1 shows the result of a test to demonstrate the possible reflection or refraction of the X-rays when incident upon two very large and white diamonds set in a ring. The gems were placed within a purse with some coins. Certain features of the cutting

seem to be very marked, and the interpretation of the result obtained presents a very interesting problem.

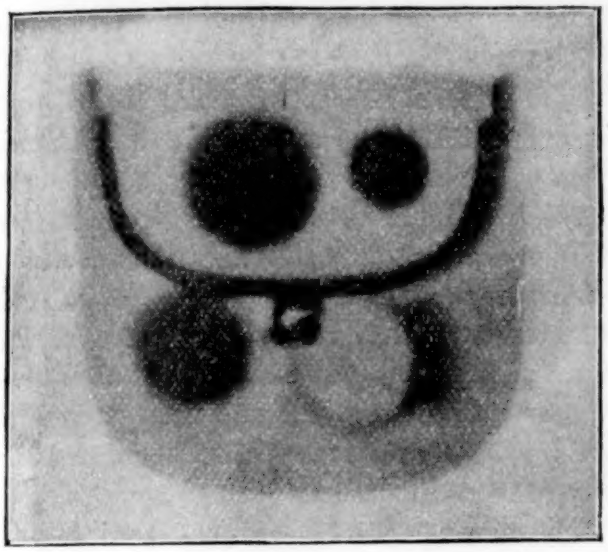

FIG. 1.

We have also demonstrated the possibility of detecting by the Röntgen process flaws or blow holes in metal plates. The writer had prepared for him three pieces of aluminum about 5 mm. thick, within which were made several hidden flaws and holes, and in one of them was placed a plug of some foreign substance, lead. A picture of the pieces reveals exactly the positions of all the holes, and a darker streak shows the position of the lead plug. Even the numbers which were stamped with a die are plainly visible in the radiogram.

It is now desired to call attention to a very interesting incident in connection with this wonderful discovery. The writer has in his possession a plate showing the impression of two coins taken on February 22, 1890, in the physical department of the University of Pennsylvania, undoubtedly by the X-rays.

On the occasion referred to many experiments were made, the object being to photograph the brush discharge, from a powerful induction machine, directly upon the sensitive plate, without any camera. Incidentally also the impressions of coins were obtained by sparking them when in contact with the sensitive film. After these experiments had been completed, a number of Crookes tubes were brought out and operated for the pleasure and amusement of Mr. W. N. Jennings, in connection with whom the work had been done.

A few days later Mr. Jennings, who had taken the plates home for development, reported the appearance, on one of them, of too very mysterious discs quite different in character from those obtained by the sparking process. No explanation was found at the time to account for the phenomenon, and the matter was forgotten till recently, when the occasion was recalled and the old plate was produced from a lot of so-called failures. On repeating the experiment by operating a Crookes tube for ten minutes, in the vicinity of an enclosed photographic plate having two coins on the outside of the box, it is found that the coin shadows are strikingly similar to the mysterious discs upon the old plate. The blurred appearance of one edge is a distinctive feature of a Röntgen picture. A print from the original plate is shown in Fig. 2. The writer and his associate wish

Fig. 2.

to claim no credit for the interesting accident, but the fact remains that without

doubt the *first* Röntgen picture was produced on February 22, 1890, in the physical lecture room of the University of Pennsylvania. ARTHUR W. GOODSPEED.

UNIVERSITY OF PENNSYLVANIA.

CURRENT NOTES ON PHYSIOGRAPHY.

CATSKILL AND HELDERBERG ESCARPMENTS.

RECENT reports of the New York State Geologist contain chapters by N. H. Darton, from which a number of interesting physiographic paragraphs may be selected; and inasmuch as there is no good account of the geography of the Empire State, all these piecemeal contributions toward it are welcome. The Helderberg escarpment in Albany county rises boldly over the broad alluvial plain formed by the Mohawk during the 'Champlain' submergence. Back of the escarpment the land rises in successive rock terraces of moderate height. The Catskill escarpment in Ulster county is the strongest feature of the kind in the eastern part of our country. Subordinate characteristics of this dominant form are found in the capture of the headwaters of certain consequent upland streams by the obsequent Kaaterskill and Plaaterskill, which are gnawing deep 'cloves' in the steep face of the escarpment and thus gaining drainage area for the subsequent Hudson valley. Among the ridges in the foreground the complicated monocline of Medina sandstone forming Shawangunk mountain is the most conspicuous. A number of geographical illustrations accompany these reports, but their reproduction is disappointing in several cases.

EXPLORATION IN LOWER CALIFORNIA.

AN account of a collecting expedition to Lower California by G. Eisen (Proc. Cal. Acad. Sci., V., 1895, 733–775), gives some notes of interest on the features of the extremity of the peninsula. Winter rains are light and rare; late summer rains are frequent and come in comparatively heavy showers; the withered shrubby growth on the mountain slopes bursts into leaf and flower when the rains begin. Very brief mention is made of raised beaches and of 'moraines,' which are described as prominent, large and steep, especially on the east slope of the mountains, where they 'all run more or less parallel from west to east' (754). The mountains, being only 7,000 or 8,000 feet high, and their eastern slope being drier than the western, it seems questionable whether these so-called moraines are authentic records of glacial action. Possibly they are dissected alluvial fans, which have not infrequently been mistaken for glacial deposits.

NIUAFOU, A VOLCANIC RING ISLAND.

LIEUT. SOMERVILLE, of the British navy, contributes an account of this remarkably perfect ring island to the London Geographical Journal for January. It lies midway between the Fiji and Samoa groups, remote from other islands. Its outer diameter is about three miles, the whole coast line consisting of forbidding black lava rocks. The caldera is about two miles in diameter, with interior cliffs of 200 or 300 feet in height. On the eastern side of the deep lake here contained is a peninsula formed by the craters of the eruption of 1886. The view from the commanding summits of the caldera ring is described as of remarkable beauty, including a great expanse of the surrounding ocean rolling under the southeast trade, the calm lake within the basin, the luxuriant vegetation on the older slopes, and the barren cinder cones of the recent outburst. A good sketch map and two views are reproduced.

THE FÆROES.

AN account of the Færoes, or Sheep Islands, is presented to the same journal by Karl Grossmann, as the result of visits

made in three recent summers. The islands result from the deep dissection and submergence of a great volcanic mass, whose nearly level lava beds determine the tables and cliffs which dominate the scenery. The exposed coasts are cut back into great sea cliffs, some of which rise 1,500 to 2,400 above the sea, exposing magnificent structural sections. Huge outstanding stacks remain in front of many cliffs.

The outer islands are reached only in fair weather and then with difficulty; their small population often being storm bound for weeks at a time. Sea birds, nestling on the cliffs, constitute an important article of food supply; the 'bird rocks' forming valuable property for the parishes to which they belong. Here the hardy custom of bird catching, while dangling from a rope let down from the cliff top, is still in practice. 'Tidal whirlpools' occur in the inner fiords; some have a diameter of thirty yards; their smooth surface, bordered by a rippling cascade, standing half a foot above the surrounding water.

MOUNTAIN WASTE IN RELATION TO LIFE AND MAN.

AMONG the *Anthropogeographische Beiträge*, edited by Ratzel (Wiss. Veröffentlichungen, Ver. f. Erdk., Leipzig, ii, 1895), is an essay by Bargmann on the forms assumed by the youngest waste building talus slopes and fans on the flanks of the northern Kalkalpen, in their relations to mountains, snow, water, plants and mankind. Various forms assumed by the waste are minutely classified. The already large area covered by waste slopes is shown to be increasing, while the naked rock area is decreasing; thus the opportunity for occupation of the mountain district by various forms of life is on the whole improving. Yet in the present phase of degradation, the modern invasion of meadows by the advancing foot of waste slopes has in a number of cases seriously reduced the value of the valley floors as pasture grounds. Some slopes of loose waste descend at angles of 44 and 46 degrees. The chapter on the manner in which waste slopes are taken possession of by plants is an excellent illustration of the relation of physiography to botany. W. M. DAVIS.

HARVARD UNIVERSITY.

CURRENT NOTES ON ANTHROPOLOGY.

WAS SYPHILIS A GIFT FROM THE AMERICAN RACE?

No doubt there is a racial nosology as well as physiology. Many writers have asserted that syphilis originated in America and was first introduced into Europe by the sailors of Columbus. Dr. Joseph Jones claims to have unearthed bones showing syphilitic caries from the ancient graves of Tennessee. In the *Journal of Cutaneous Diseases*, October, 1895, Dr. A. S. Ashmead argues that syphilis was autochthonous among the Aymaras of Bolivia, and quotes Forbes as to the possible origin of it from the alpaca, an animal which suffers from it in a malignant form. Dr. E. Seler, in the *Verhandlungen* of the Berlin Anthropological Society for 1895, has a learned article to support the view that it was prevalent in Mexico before the conquest.

On the other hand, in the same volume, (p. 454), Prof. Virchow declares he never saw a syphilitic bone from an ancient American grave; that the disease was known in Europe certainly as early as 1472, and was prevalent in Japan in the ninth century.

ETHNOLOGY, GEOGRAPHY AND HISTORY.

THE relations of these three sciences are discussed by T. H. Achelis in the *Globus* 1896, No. 4. He regards ethnology as a strictly empirical study, 'wholly without metaphysical tendencies.' Its ultimate aim is to define the human soul by a thorough collation of all that it has actually achieved,

as in religion, mythology, law, art, etc. In primitive conditions man's activities are powerfully influenced by his geographic environment, but this diminishes as culture increases. The proper aim of ethnography is not to search out relations of blood, but similarities of culture. Above these stand the universal traits of human psychology, which can be defined only by careful collection and comparison of ethnic details. Degenerations and deteriorations in culture do not belong of right to ethnologic study, because this has as its purpose the definition of evolution or the advancement of the species. He refers to Post, Bastian, Ratzel and Andree as the best representatives of this new school of ethnology.

It is proper to add that their opinions have not yet received universal, scarcely general, acceptance from other nations.

MENTAL VERSUS PHYSICAL IN WOMAN.

THERE is a prevailing impression that women in the higher classes of civilized society are less desirous and less capable of having numerous offspring than those of the lower classes and ruder conditions. In other words, that there is an antagonism between the intellectual culture of woman and her reproductive powers. One or the other must suffer in her education.

The sociological importance of such a fact, if it is one, can scarcely be over-estimated. Were it proved, and no remedy be found, it would mean the gradual extinction of the most cultured classes in the community. The question was presented by me before the anthropological section of the Academy of Natural Sciences, Philadelphia, and an abstract published in the *Medical News*, January 18, 1896, under the title 'The Relations of Race and Culture to Degenerations of the Reproductive Organs and Functions in Woman.' I shall be glad to send a copy to any reader of SCIENCE who wishes one.

D. G. BRINTON.

NOTES ON AGRICULTURE AND HORTICULTURE. (IV.)

TREATMENT OF PEACH ROT AND APPLE SCAB.

DELAWARE is a small State, but large in its peach industry. The leading enemy to the peach crop, the fruit rot, naturally is a subject that demands the attention of the Station Mycologist, Prof. F. D. Chester. For several years he has been testing various fungicides for the rotting of the fruit, and the last bulletin (No. 29), recently issued, gives both the results of the experiments and general directions for spraying. It is recommended to remove and burn all dried or mummified fruit from the peach trees in winter and to spray the trees in early spring with bluestone solution. When the fruit buds begin to swell spray with the Bordeaux mixture and again just before the buds open. Spray again with Bordeaux when the bloom is falling, and add a little Paris green to keep off the curculio. About two weeks later the same treatment is repeated. As the Bordeaux coats the fruit with the lime mixture, for the last two sprayings copper acetate, a colorless solution, is employed. A tenfold increase of sound fruit was obtained by this process at a cost of about twelve cents per tree.

The treatment for apple scab was the Bordeaux mixture, to which London Purple had been added and applied five times to the trees. The good fruit was doubled by this treatment, while the general health of the apple trees was much improved.

LEGISLATION AGAINST WEEDS.

THE division of Botany U. S. Department of Agriculture has just issued a bulletin (No. 17), prepared by Mr. L. H. Dewey, "in response to a growing demand among agriculturists and Legislators for data which will enable them to prepare laws better adopted for the control of weeds than those now in use." One per cent. of increase in

the crops, which might be obtained by weed destruction without much cost, would amount to $17,000,000. The passage of proper laws against weeds is important and should be effected with dispatch.

The weed laws are listed as found upon the statute books of the following States: Arizonia, California, Connecticut, Delaware, Illinois, Indiana, Iowa, Kansas, Kentucky, Maryland, Michigan, Minnesota, Missouri, Nebraska, New Jersey, New York, North Dakota, Ohio, Oregon, Pennsylvania, South Dakota, Vermont, Washington, West Virginia, Wisconsin. Thus twenty-five States and Territories have laws against weeds. In some States the law is to suppress but a single species, as against Canada thistle in California, Delaware, Kentucky, while other States proscribe fourteen, as in Minnesota and Ohio. The largest proscription is with the Canada thistle, twenty-one out of twenty-five States. Six States legislate against the Russian thistle.

The fact that there is no federal law against weeds is probably because no one species is national in importance, but the Russian thistle may become such if it spreads as it is feared.

The basis for a general weed law is given and includes as a leading feature a commission of which the State botanist shall be the head. It is very important that new weeds shall be recognized and measures taken to eradicate them at once. Legislation for the purity of seeds will do much to check the introduction of weeds through commercial seeds.

BACTERIA IN THE DAIRY.

DR. CONN gives a 'year's experience with Bacillus No. 41 in general dairying' in the Annual Report of the Storr's Experiment Station of Connecticut. This germ can produce a pleasant flavor in butter, if favorably situated in the cream, and is feasible in the hands of ordinary dairymen. The flavor thus produced is retained by the butter for a long time. It is not proved that this bacillus is the best possible one for this purpose, but Dr. Conn thinks the method is at least correct in principle and will succeed in practice.

SUB-IRRIGATION IN THE GREENHOUSE.

THE Ohio Experiment Station is taking a lead in the study of irrigation under glass by Prof. W. J. Green. In a recent bulletin the construction of the greenhouse with iron frames and bench tiles is fully shown by engravings, as also the great difference in the size of lettuce grown with sub-irrigation and surface watering, it being twice as large with the former as the latter method. The idea of irrigating below the surface grew out of an attempt to prevent the rotting of lettuce by not wetting the foliage. Sub-irrigation is cheaper than the old method of surface watering; the soil remains in a better condition and the plants are less liable to decay. These results come largely from the soil permitting the air to pass freely through it, besides supplying water constantly to the roots.

GRAPE CULTURE.

SOME of the Experiment Stations bulletins are books and not small ones. Sixty-four pages of close print interspersed with engravings is issued by the Georgia Experiment Station as its bulletin No. 28. The Horticulturist H. N. Starnes does not conceal the intent of the publication, but at the outset states that "no attempt has been made to treat the subject from a scientific standpoint, and as far as possible all technicalities have been avoided, as the bulletin is intended solely for the practical guidance of the inexperienced beginner." The booklet is divided into nine parts, namely, the vineyard, propagation, planting, pruning and training and so on.

BYRON D. HALSTED.

RUTGERS COLLEGE.

SCIENTIFIC NOTES AND NEWS.

THE WOODS HOLL MARINE BIOLOGICAL LABORATORY.

The Eighth Annual Report of the Trustees of the Marine Biological Laboratory at Woods Holl has just been issued, and shows that the summer of 1895 was the most successful in the history of the Laboratory. At different times during the summer there were 63 investigators present, 42 of whom occupied special research rooms. There were 101 students taking introductory courses. The whole number of students who have attended the Laboratory since 1888 is 483. The attendance of investigators has been very greatly increased by the system of coöperation with the colleges and societies, which began in 1894. At present 25 colleges subscribe for investigator's rooms, besides five societies, including the American Association for the Advancement of Science and the American Society of Naturalists.

The year has been a successful one financially owing to the large number of students present who have paid for their instruction or through the colleges for the investigators' rooms or tables. A few years back it was necessary to make up a large deficit at the end of the year, while the past year's income exceeded the total expenses by nearly $1,000. There still remains, however, a debt of $5,985. Since this report was prepared, a meeting of the Trustees was held in Boston to revise the constitution of the Laboratory, and the following general plan was submitted: To place the entire financial interests of the Laboratory in the hands of a special finance committee. Second, to constitute from the present Board of Trustees a number of committees. Finally, to constitute from the staff at Woods Holl and from representatives of coöperating colleges a scientific board of direction, who, with the Director, will control the entire policy of the Laboratory and its general administration.

Encouraged by this successful year the Director, Professor C. O. Whitman, naturally closes with a strong appeal for an expansion of the resources of the Laboratory in the form of endowments. He proposes that tables shall be endowed at $1,250; investigator's rooms at $2,500; scholarships at $200, and fellowships at $500. The library needs $1,000 per year to keep it supplied with current publications. The publication fund should amount to $2,000 annually. But the chief feature of the proposed expansion is a main building for the exclusive use of investigators, providing for library, auditorium, aquarium, laboratories, etc., which would cost about $100,000. These steps would be necessary to found an inter-collegiate Biological Station, with an annual outlay of not less than $50,000.

In order to support this ambitious plan, the Director presents an exceptionally full and able report, tracing the whole past history of the Laboratory. His main contention is that the Laboratory was founded for *instruction* as well as for *investigation* in Biology, and that at the outset it was proposed to establish an ideal Biological Station, organized on a basis broad enough to represent the important features of the several types of laboratories hitherto known in Europe and America. The report aims to show that the elementary instruction department (a feature which distinguishes the American station from all those in Europe) is necessary in order to train the investigators, or, to use his own language:

"The instruction cannot be made too strong, for its strength is continually being transferred to investigation; and every proper expansion of investigation must react to improve and enrich instruction." He goes on to say that the instruction has not interfered with investigation, because the investigators have increased almost as rapidly as the elementary students. There were 9 investigators in 1888 and 63 in 1895. There were 8 elementary students in 1888 and 101 in 1895. He concludes: "Comparing the last four years of growth with the first four, it will be seen that we moved on with no very great gains in the earlier period, while the later period is marked by a sudden rise in standing, 50 per cent. of membership, and a gain of over 100 per cent. on the investigator's side. In 1894 a new laboratory was constructed and the Director recommends the construction of another temporary laboratory in 1896, in order to meet the pressing needs of the present growth. Much progress has been made in the general financial support of the Laboratory, which has

hitherto fallen upon the generous Trustees from Boston and their friends, not only by the aid of the thirty coöperating colleges, but by the formation of the 'Biological Association,' the chief object of which is to aid the Laboratory in securing funds necessary to the foundation of a biological station as a National center of research in every department of biology. Local committees have also been formed, such as those in New York and Philadelphia."

During the year a large number of evening lectures were given by well-known morphologists and physicists, and the daily morning lecturers include a very large number of well-known names. Besides this, there has been regular instruction in vertebrate and invertebrate morphology and a course in embryology.

THE RÖNTGEN RAYS.

SOME twenty papers on the Röntgen rays have already been presented before the Paris Academy of Sciences. On February 10th M. C. Henry reported that coins coated with phosphorescent zinc sulphide lose their opacity to the rays. *Nature* thus summarizes the papers presented on February 17th: "In following up the analogy of certain properties of these rays with some properties of the ultra-violet rays, M. R. Swyngedauw has found that the X-rays cause a lowering of the explosive potential according to the same general laws as the electrically active ultra violet rays. Whilst the influence of the latter, however, is entirely suppressed by interposing a screen of wood, glass or blackened paper, these materials do not effect this property of the Röntgen rays. It was also noticed that these rays lowered the dynamic explosive potentials to a greater extent than the static potentials. As a result of the study of the property of the Röntgen rays of discharging an electrified body, M. A. Righi concludes that the time necessary for a given fall of potential is practically the same, whether the original charge be positive or negative. With an initial positive charge the discharge is not complete; but if negative initially, not only is the discharge complete, but the disc becomes positive. The results obtained by MM. J. J. Borgman and A. L. Gerchun, however, are precisely contrary to these, a positively charged disc losing its charge nearly instantaneously, and becoming negative on prolonged exposure to a Crookes' tube. MM. L. Benoist and D. Hurmuzescu contribute further researches on the same subject of a quantitative character. By measuring the time required for a given reduction of angle between the leaves of an electroscope and the distance of the leaves from the Crookes' tube, they prove that the ratio of the times are as the ratio of the squares of the distances. From the coefficient of transmission (0.85) of an aluminium plate, 0.1 mm. thick, it is shown that a plate of aluminium 15 mm. thick, such as was used by Röntgen in his original experiments, must be practically opaque to the rays *unless the rays are heterogeneous*. In an extract from a letter by de Heen an ingenious experiment is described which proves conclusively that the X-rays proceed from the anode, and not the cathode. A leaden plate perforated with holes is placed between the Crookes' tube and the photographic plates, and the direction of the bundles of rays obtained shows clearly that these rays are anodic.

ASTRONOMY.

THE Munich Observatory has just issued a very elaborate investigation of astronomical refraction from meridian circle observations made for this special purpose by Dr. Julius Bauschinger. The instrument used was the new six-inch, which was set up towards the end of 1891. The present series of observations are therefore the first ones made with this instrument. The method employed was the usual one of comparing the declinations oi the same star obtained at the upper and lower culmination. The paper as a whole impresses one with the extraordinary care and thoroughness with which every part of the work has been done. We can, of course, only touch very briefly upon a few points that appear of special interest.

No corrections for errors of the microscopes, errors of division of the circle, or flexure of the tube, were applied to the observations, as very careful investigation of all these matters showed that the existence of such errors was not established with certainty. This speaks very highly for the skill of the instrument

makers, Messrs. Repsold, of Hamburg. Great care was given to the reduction of the observations of the meteorological instruments, the pressure of the aqueous vapor in the atmosphere being taken into account. The corrections for variation of latitude which have been applied to the observations were deduced from the series itself, because the author did not want to let his results depend upon the work of others. Perhaps it would have been better to have employed some of the contemporaneous series of latitude variation observations for the correction of Dr. Bauschinger's results. They are not completely independent as they stand, because the constant of aberration was not determined from them. The usual Pulkowa value was used in the reductions.

Passing over a number of very interesting special investigations of various points, we shall call attention to the two most important results obtained by Dr. Bauschinger. He finds for the refraction constant at 760 mm. pressure, and 0° Centigrade, the value 60''104, indicating a considerable reduction of the Besselian constant. That such a reduction of the Besselian constant was needed, had already been shown to be probable by other recent investigations. The other important result is a very accurate declination catalogue of 116 principal stars for the epoch 1892. Radau's new refraction tables were employed throughout the work.

THE Jablonowski Society, of Leipzig, has published in a book of 280 pages octavo, a treatise on the Secular Variations of the Orbits of the Major Planets by Dr. Paul Harzer, Director of the Gotha Observatory. This work has received the Society's prize. H. J.

GENERAL.

THE Secretary of the Interior has requested the National Academy of Sciences to report on a forestry policy for the government with special regard to the following questions: (1) Is it desirable and practicable to preserve from fire, and to maintain permanently as forested lands, the wooded parts of the public domain, for the supply of timber? (2) How far does the influence of forest upon climate, soil and water conditions make a policy of forest conservation desirable in those regions where most of the public domain is situated? (3) What specific legislation is required to remedy the evils now existing? A commission has been appointed by the Academy consisting of the following: Prof. Charles S. Sargent, Chairman; Prof. Alexander Agassiz, Gen. Henry L. Abbott, Prof. William H. Brewer, Mr. Arnold Hague and Mr. Gifford Pinchot.

AT a meeting of the Board of Managers of the New York Botanical Garden on March 4th plans were considered for a museum building and sketches for greenhouses were exhibited. The Secretary was instructed to exhibit topographical maps of the garden site at the annual reception of the New York Academy of Sciences, on March 26th.

THE United States Senate has passed the agricultural appropriation bill carrying appropriations amounting to $3,262,652.

As previously announced Sir Joseph Lister will preside over the Liverpool meeting of the British Association. The presidents of the sections will be as follows: Mathematics and Physics, Prof. J. J. Thomson; Chemistry, Dr. Ludwig Mond; Geology, Mr. John Edward Marr; Zoölogy, Prof. E. B. Poulton; Geography, Major Leonard Darwin; Economics, Right Hon. Leonard Courtney; Mechanical Science, Sir Charles Douglas Fox; Anthropology, Mr. Arthur Evans; Physiology and Pathology, Dr. Walter Holbrook Gaskell; Botany, Dr. D. H. Scott.

AN Anthropological Club for informal discussion was formed in New York on March 4th. Some fifteen students of anthropology met at the house of Dr. Franz Boas and discussed the recent works on children and child psychology by Sully, Baldwin and Chamberlain, the books being reported on by Prof. Giddings, Dr. Farrand and Dr. Boas, respectively. Meetings will be held monthly, but no formal organization is proposed.

ARRANGEMENTS have, however, been made for the more formal recognition of the mental and social sciences by the formation of a section of the New York Academy of Sciences devoted to anthropology, psychology and philology. Several members of the Academy were

engaged in the study of these sciences, and a number of new members have been elected and nominated with a view to the organization of this section. The Academy now meets in three sections—Astronomy and Physics, Biology, and Geology and Mineralogy—which take up the evenings of the first three Mondays of the month. The fourth Monday will be alloted to the new section. At the first meeting, which will be on April 27th, papers will be presented by Drs. Giddings, Cattell, Farrand and Boas. For the May meetings a philological program will be arranged.

THE annual exhibition and reception of the New York Academy of Sciences will be held on the evening of March 26th at the American Museum of Natural History. The two exhibitions that have preceded have been very successful both from a scientific and from a social point of view, and the program and arrangements of the present meeting promise an even more notable success. Many of the exhibits, representing the progress of science during the past year, are sent from places outside New York, and members of scientific societies in other cities will be welcomed at the reception. Invitations may be obtained from the chairman of the executive committee, Prof. H. F. Osborn, Columbia University.

PRESIDENT CLEVELAND has been invited to formally open the International Commercial Museum at Philadelphia in the autumn.

THE *British Medical Journal* states that in the course of a communication to the Paris Société de Biologie on Feb. 22d, M. Chantemesse said that last June he had succeeded in immunising several horses against the virus of typhoid fever. He had obtained the serum of such strength, that one-fifth of a drop inocculated into a guinea-pig twenty-fours before infection protected it against a dose of typhoid virus fatal to animals not previously injected with the protective serum. It was ascertained, also, that injections of the serum produced no injurious effects upon a healthy man. M. Chantemesse stated that he had since employed injections of serum in three cases of typhoid fever. The temperature showed a regular fall from the time the first injection was made, and seven days after the commencement of the injections all three patients were quite free from fever, and had commenced to convalesce. M. Chantemesse added that the cases were not yet sufficiently numerous to permit any trustworthy conclusion to be drawn.

AT a meeting of the board of managers of the National Geographic Society, on March 6th, Mr. Grip, the minister of Sweden and Norway, asked the Society's assistance in distributing among the inhabitants of arctic America sketches of the balloon to be used by Mr. Andrée, and explanations in native languages in order "to prepare the populations of those northern tracts for the possible appearance at their places of the balloon and its occupants, partly in order that they may report the balloon if they should see it at a distance, and partly to prevent them from doing any harm to its occupants when they descend unexpectedly."

MR. W. J. L. WHARTON states in *Nature* that Captain Balfour, of H. M. S. *Penguin*, has obtained three soundings of over 5,000 fathoms, the deepest being 5,155 fathoms. The positions of the soundings are :

Lat. S.	Long. W.	Depth. Fms.	Depth. Feet.	Nature of bottom.
23° 39′	175.04	5022	30,132	(Wire broke.)
28° 44′	176.04	5147	30,882	Red clay.
30° 28′	176.39	5155	30,930	Red clay.

The extreme soundings are 450 miles apart, and are separated by areas of considerably less water. The deepest trustworthy sounding heretofore known is 4655 fathoms near Japan, obtained by U. S. S. *Tuscarora* in 1874.

MR. ROY W. SQUIRES goes to Venezuela as a representative of the department of botany of the University of Minnesota and under the auspices of the Orinoco Company. He will make collections in the unexplored mountain regions southeast of Barancas. The region covered will lie considerably south of that visited by previous botanists and a valuable collection may be looked for. Mr. Squires will be absent from Minnesota about six months.

WE regret to learn that Dr. Herbert Haviland Field is seriously ill at Zurich and is at present prevented from attending to his work in the

Bibliographical Bureau. A temporary substitute has been engaged but the progress of the bibliography will be seriously impaired. It is especially unfortunate that Dr. Field (having after his prolonged efforts successfully established the Bureau) should now be incapacitated. The future of the Bureau seems to depend mainly upon his efforts, and all who are interested in his work hope to hear of his rapid recovery.

ARNULF SCHERTEL describes, in the last *Berichte*, a new method of preparing Platinocyanids. Platinum chlorid is precipitated by hydrogen sulfid at 60° to 70° and the well washed platinum sulfid dissolved in a warm solution of potassium cyanid. On evaporation the potassium platino-cyanid, $K_2Pt(CN)_4, 3H_2O$, crystallizes out, and equal parts of potassium sulfid and potassium thiocyanate remain in the mother liquor. If a solution of barium cyanid is used, the barium platino-cyanid is obtained, with commercial potassium cyanid containing large quantities of sodium cyanid, Schertel obtained the beautiful double salt $KNaPt(CN)_4, 3H_2O$, described by Martius. In view of the fluorescence of the barium and other salts of the platino-cyanids under the Röntgen rays, this simple method of preparation is of considerable interest.

IN 1888 crania of *Sorex personatus* and *Synaptomys cooperi* were taken about eight miles from Washington, in pellets ejected by a long-eared owl. This was of interest, since it was the first occurrence of *Synaptomys* farther east than Indiana, but it was of course an open question as to just how near Washington the specimen might have been captured, and, until recently, all attempts to take either of these little mammals near the capital have been fruitless. On January 25th Mr. Vernon Bailey read a paper before the Biological Society on Tamarack Swamps as Boreal Islands in which he took the ground that the abundant sphagnum of these swamps played a very practical part in reducing the temperature by evaporation, and thus rendering them habitable for boreal animals. In the discussion which followed the paper Mr. Bailey was apprised of the existence of such swamps near Washington, and immediately proceeded to test his theory by setting a number of traps in one of them, with the result that in less than a week he obtained examples of both *Sorex personatus* and *Synaptomys cooperi*.

THE extensive mycological herbarium of Mr. J. B. Ellis, of Newfield, New Jersey, has been purchased by the Board of Managers of the New York Botanical Garden, and will be deposited in the fire-proof museum building of the Garden to be erected in Bronx Park. The purchase includes a considerable portion of Mr. Ellis' library. The collection is now being boxed for transportation and will be brought to New York within a short time and placed in one of the fire-proof storage warehouses, awaiting its final resting place at the Garden. The herbarium represents the work of nearly fifty years devotedly given by Mr. and Mrs. Ellis to the study and accumulation of Fungi from all parts of the world. It is especially rich in North American species, being, indeed, very nearly complete in that regard, and containing all or very nearly all the types described either by Mr. Ellis alone, or in coöperation with Dr. H. C. Cooke, Mr. B. M. Everhart, Mr. E. W. Martin, Prof. W. A. Kellerman, Rev. A. B. Langlois, Mr. E. D. Holway, Mr. B. L. Galloway and others. It is put up in volumes, there being some 250 volumes of published exsiccati, including all but a very few of the earliest distributed sets and more than 150 volumes of a general collection, the whole completely indexed on a card catalogue. There are also more than 100 tin cans and boxes filled with fleshy fungi. The possession of this important collection will make the new botanical institution a center of interest for all students of these plants, and, with the other herbaria already secured, will guarantee its scientific prestige.

CORNELL University has formally acquired the famous quadruple-expansion steam engine, built for a steam pressure of five hundred pounds, in the Sibley College shops, by Messrs. Hall and Treat. This engine was designed in accordance with the principles taught its builders, in Sibley College, and for a very exceptionally high steam pressure; the purpose being to ascertain whether the promised advantages of such intense pressures could be realized. The University gave the use of shops and tools

and such material as could be supplied without serious cost, and the makers furnished time and labor, and, at their own cost, put in the boiler, an extraordinary construction built for specially high pressures and actually tested to 1300 pounds per square inch. The engine and boiler will hereafter constitute an important portion of the Sibley College equipment, and is expected to do wonderful work. It is already known to be capable of excelling the world's record in economy, on saturated steam; although that record is at present held by a triple-expansion engine of thirty times the size of the Sibley College quadruple expansion engine. A series of trials has been conducted by the builders and the results will be published later as a thesis, by the builders, both of whom are graduate students, candidates for advanced degrees. Meantime, it is known that the engine has developed twenty horse-power, its rated work, on a consumption of less than ten pounds of steam, less than 11,000 *B. T. U.* per horse-power per hour. The College will supplement this work by still more elaborate trials, and in the expectation of still further reducing the figure. Mr. Hall, the senior of the designers and builders, has been, for some years past, the stroke oar of the Cornell ''Varsity' crew.

THE annual general meeting of the Institution of Mechanical Engineers was held at London on January 30. The report of the council stated that at the end of last year the number of names in all classes on the roll of the institution was 2,270, as compared with 2,222 at the end of the previous year. The council had bought a site at Storey's gate, Westminster, with the view of providing a permanent home for the institution. Contracts are being prepared for a building, and it was hoped that next year the house would be completed. Amongst other technical matters which had been dealt with by the council during the year, the report mentioned a memorial to the President of the Local Government Board for the repeal of existing statutes so far as they prevented mechanical locomotion on common roads, apart from traction engines. Should the appeal prove successful the council were sanguine enough to anticipate with confidence the speedy development of a branch of mechanical engineering, which might even call forth an amount of enterprise exceeding anything that had yet arisen in connection with the remarkably rapid growth of the cycle manufacture.

ATTENTION may be called to the fact that the Academy of Natural Sciences of Philadelphia holds in trust the sum of $2,500, given by Mrs. Emma W. Hayden for a Hayden Memorial Geological Fund, in commemoration of her husband, the late Prof. Ferdinand V. Hayden, M. D., LL. D. According to the terms of the trust, a bronze medal and the balance of the interest arising from the fund are to be awarded annually for the best publication, exploration, discovery or research in the sciences of geology and paleontology, or in such particular branches thereof as may be designated. The award and all matters connected therewith are to be determined by a committee to be selected in an appropriate manner by the Academy. The recognition is not confined to American naturalists.

UNIVERSITY AND EDUCATIONAL NEWS.

THE suit of the United States against the executrix of the late Senator Stanford, for over $15,000,000, has been decided by the Supreme Court of the United States in favor of Mrs. Stanford. The future endowment of Stanford University depended on this decision.

THE will of the late Hart A. Massey, of Toronto, leaves about $650,000 to educational and charitable institutions, including the following bequests: Victoria College, Toronto, $200,000; Wesley College, Winnipeg, Man., $100,000; Mount Allison College, Slackville, N. B., $100,000; Wesleyan Theological College, Montreal, $50,000; American University, Washington, D. C., $50,000.

THE finance committee of the Senate of the State of Virginia has presented a bill appropriating $50,000 annually, instead of $40,000 as heretofore, to the University of Virginia.

THERE has been organized at Indianapolis a University of Indianapolis consisting of Butler College, the Medical College of Indiana, the Indiana Dental College and the Indiana Law School. These institutions have at present about 1000 students.

The will of the late Charles L. Colby, of New York, bequeaths $20,000 to Brown University.

Morris M. White and Francis T. White have given Earlham College, a Quaker institution in Richmond, Ind., $25,000, to be added to the endowment fund and to be known as the John T. White memorial fund, in honor of their father.

Mrs. Josiah Fiske, of New York city, has given $5,000 to Radcliffe College in memory of her late husband. The College has also received $6,568, the balance of a bequest by the late Caroline B. Perkins.

Mr. T. E. Bondurant, of De Land, Ill., has offered to give $20,000 to the endowment fund of Eureka College, Illinois, provided the Board of Trustees will secure $100,000 additional by the first of March, 1897. Mr. T. J. Underwood, of Sangamon County, Ill., has donated $10,000 towards the fund.

Prof. G. F. Atkinson has been made full professor and head of the department of botany at Cornell University, succeeding Prof. Prentiss, who has held this position since the organization of the University.

Dr. E. B. Delabarre, professor of psychology at Brown University, has been appointed director of the psychological laboratory at Harvard University during the absence of Prof. Münsterberg. Dr. Mark Wenley, recently Examiner in Philosophy to the University of Glasgow, and Lecturer at the Queen Margaret College, has been appointed Professor of Philosophy in the University of Michigan.

The committee of fifty-one, in charge of the project for the removal of Union College to Albany, at a meeting in that city on February 26th, decided to present to the Legislature a bill calling for the bonding of the city for $1,000,000 for the purpose.

A public meeting on behalf of the University College of Wales was held in Cardiff, on February 5th, under the presidency of Lord Windsor, with a view to raise £20,000 required to meet conditional grants from the Treasury and the Drapers' Company in aid of the building fund of the college. Subscriptions amounting to £13,400 were promised, including one of £2,500 from Lord Windsor.

At a meeting of the Senate of the University of London, on February 19th, Sir Henry Roscoe was elected Vice-Chancellor of the University, in the room on the late Sir Julian Goldsmid.

At a meeting of the Convocation of Oxford University the proposal to allow women to take degrees was rejected by a vote of 215 to 140. A similar proposal will soon be voted on at Cambridge, where the movement to admit women to degrees is probably stronger than at Oxford.

DISCUSSION AND CORRESPONDENCE.

CHUAR, HEGEL AND SPENCER.

It is with much hesitation that one undertakes to criticise or even comment upon a paper written in the style of that by Major Powell which appeared in Science on February 21st. The author speaks with such authority regarding the nature of matter and mind, and rebukes so firmly the philosopher and the metaphysician, that one shrinks from indicating even by a question that one may be numbered with such, or, at least, found in the class of their admirers. No one likes to confess that he is the subject of 'feverish dreams;' or write himself down as a 'wrapt dreamer' who 'imagines that he dwells in a realm above science—in a world which, as he thinks, absorbs truth as the ocean the shower, and transforms it into a flood of philosophy' (p. 271). It must be to any conscientious man a matter of sincere regret that he has cast over some unoffending physicist 'the spell of metaphysics,' and made him turn from that useful tool the spectroscope with the despairing exclamation that 'all his researches may be dealing with phantasms!' I cannot, of course, speak for Chuar, who, as a savage, has a right to be shameless, but I cannot but think that both the shade of Hegel and the living Spencer would be loth to confess themselves 'immersed in thaumaturgy,' and lovers of the wonderful, who, 'in the revelry developed by the hashish of mystery' find 'the pure water of truth' insipid (p. 269).

Nevertheless, as one who has spent several

years in studying the works of the philosophers, and as one willing to pocket his pride for the sake of extending his knowledge, I feel impelled to confess that there are many things in Major Powell's paper which are not clear to me. The fault is doubtless mine, since the paper is an exposition of 'the true and simple,' loved by the spirit of sanity extant among mankind 'in the grand aggregate' (p. 269). I can touch upon but one or two of the points which perplex me.

Those of us who busy ourselves with the history of philosophy are accustomed to believe that there are philosophers of many kinds, some of whom believe in 'substratum' *et id omne genus*, and some of whom hold such things in derision. Had not the author set himself over against philosophers in general as the champion of sanity, I should have been inclined to class him among them and describe him as a Positivist of a somewhat naïve sort. Did not Comte confine human knowledge within the limits of the phenomenal? Did he not reduce cause and effect to antecedent and consequent? Was he not the avowed enemy of all 'reification?' Did not Berkeley and Hume and Mill handle without gloves the notion of 'substratum' here attributed to philosophers generally? One seems to be listening to an old, old story; and yet there must be some mistake, for all these men are everywhere allowed to pass unchallenged as philosophers, and so must have been addicted to something stronger than 'the pure water of truth.' As to the classification of Hegel with Chuar and Spencer, those who think they understand Hegel (and there are such) stoutly maintain that he did not believe in 'substratum,' and that it was in throwing away the remnant of it left by Kant that he has earned the gratitude of posterity. It is, of course, possible that Major Powell has made a more careful study of his works than they, and has discovered a real similarity between his doctrine and that of Spencer.

The passages which dwell upon the constitution of matter occasion me no less perplexity. "All matter has four factors or constituents, number, extension, motion and duration, and some matter at least has a fifth factor, namely judgment" (p. 265). To one not habituated to 'the true and simple,' this seems at first glance 'reification' of the worst sort.

These 'entities' (I use the word for want of a better) are made factors or constituents of matter. The first four, of which alone I wish to speak just now, are not commonly regarded as of such a nature that when put together they can make a thing. The Pythagoreans have been criticised for 'reifying' number in making it the principle of all things. Descartes has been criticised for treating extension in much the same way. Major Powell goes further and 'reifies'—what other word can one use?—motion and duration. Why he left out impenetrability it is hard to say, but that may be explicable as an oversight, for the article bears the marks of having been hastily written. Why he chose motion and duration, I cannot conceive. Can we think of these as constituents of matter?—as constituents of the ultimate chemical particle to which he refers (pp. 265 and 270)? Some of the philosophers who object to the reification of things define motion as the change of spatial relations between material objects. If such be motion, it is difficult to think of motion as a constituent of an atom. If motion be something else, it would be interesting to have it defined. Is all its motion present to an atom at a single instant as all its extension is? Or can an atom at a single instant be said to have motion at all? I almost slipped into saying 'be *in* motion at all,' but such an expression must be abandoned; the atom's motion must be, so to speak, in it. Those who are not ashamed to read the works of the philosophers will remember that this difficulty about having motion at a single instant came to the surface something more than two thousand years ago. And if the motion in question is merely a factor of the atom, a constituent, is it not fair to suppose that an atom may have motion without changing its place at all? What have external relations to do with the existence of the constituents of this particular atom?

As to duration. Here the difficulty is as great. Can an atom have its duration all at once? Must it not take it bit by bit as it comes to it? Then the duration which helps to constitute the atom must at each instant be different from that

which plays its part as factor at the next. A further difficulty rises with the thought that, perhaps, after all, duration cannot have its being in a single instant, but needs at least two to be duration. The atom at any instant is just what it is, and is made what it is at that instant by the presence of all its four constituents. If duration needs more than one instant to be duration, how can it be present at a single instant? That duration really implies more than a single instant seems clear from the fact that "in the material world we have no knowledge of something——which has not duration as persistence or duration with persistence and change" (pp. 270–271). Surely a thing cannot persist all in an instant any more than a bird can flock all by itself, or one man look alike. There are philosophers 'lost in the meaning of words, forever wandering in linguistic jungles' (p. 266), who have maintained that duration is nothing but a name for a certain kind of order in things, the order we call successive. Such philosophers, 'in the revelry developed by the hashish of mystery,' protest against the reification of duration, and even so far forget themselves as to denounce the tendency to reify it as a lapse into mediævalism. Making it a constituent of matter they regard as reifying it, and they are capable of interrupting a man at a spectroscope with the diabolical suggestion that they would as lief reify the relations 'greater' or 'smaller,' as the philosopher did when philosophy was in its infancy.

Regarding the fifth factor, which serves as a constituent of some matter—'judgment'—Major Powell's expositions do not appear to me luminous. Many views have been held as to the relations of mind and body, and even philosophers have not been at one as to the particular sort of mystery in which they would decide to revel in discussing this problem. Most of them now speak with some hesitation upon the subject, and confess that the problem is difficult of solution. To Major Powell it is as clear as noon-day. There is matter which consists of number, extension, motion and duration, and there is other matter which consists of these with the addition of judgment. But bodies consist of ultimate particles. In describing in what these ultimate particles resemble each other and in what they differ, the author seems to have overlooked this fifth factor, which is to differentiate some particles from others (p. 265). This must be an oversight, for are not the two classes clearly distinguished as different in the number of their constituents? And are we not informed that the constituents 'are never dissociated, but constitute matter' (p. 265). The chemist has then to reckon with chemical particles which have judgment and those which have not. Presumably more or less of the former are found in the human brain, and the chemist of our day should not overlook them. We have here a new kind of atom, more complex in its nature than other atoms, and gifted with a constituent of a very remarkable sort. Since the five constituents are never dissociated, we may expect to find such atoms also in other situations, where the common man never thinks of looking for judgment. And this fifth constituent has the peculiar faculty of developing 'into cognition of the constituents of matter, of their relations, and also a cognition of cognitions and the relations of cognitions' (p. 268). Notwithstanding this surprising development, it presumably still remains a constituent of the atom. Since brains consist of nothing but atoms, and nonentities must not be reified, this factor, to be real at all, must be a constituent of individual atoms. And since the atoms in brains keep coming and going, the careful observer may reasonably hope to find such atoms everywhere, with their fifth factors developed into a 'cognition of connitions and the relations of cognitions.' It is gratifying to one who finds all this obscure to be told that "science does not lead to mystery but to knowledge, and the mind rests satisfied with the knowledge thus gained when the analysis is complete." We are quite willing to take the author's word for the fact that it is here complete, but we must confess with humility that we walk by faith.

Having nerved ourselves to the effort of accepting the two kinds of matter as a refuge from mystery, we feel a mild wonder at certain sentences which seem to indicate that there are, after all, two worlds and not one. "Concepts of number, extension, motion, duration and judgment are," we are informed, "developed by

all minds, from that of the lowest animal to that of the highest human genius" (p. 269). What is this mind, of which the author speaks? And what is meant later by the author's division of reality into 'the material world' and 'the mental world' (p. 271), or 'the material world' and 'the spiritual world' (ibid). If we are dealing with indissociable constituents of matter, would it not be as wise to speak of 'the material world' and 'the world of duration,' or 'the material world' and 'the world of motion?' But I waive these questions, as being possibly the products of a 'feverish dream.' It must be accepted as a general answer to all such, and a sufficient consolation to the discontented, that 'the simple and the true remain' (p. 271).

As a last word I may add that the more sober of the philosophers of our time have, notwithstanding 'the intoxication of illusion,' been accustomed to think that it is not prudent for a philosopher who has no special knowledge of the subject to venture into other fields, as, for example, that of anthropology. Some even go so far as to believe that it is not wise for an anthropologist to venture into philosophical discussions unless he has acquainted himself with the writings of those who have preceded him in work of that kind. Perhaps it is because they are 'immersed in thaumaturgy' that they find in such contributions to philosophical literature more heat than light.

GEORGE STUART FULLERTON.

UNIVERSITY OF PENNSYLVANIA, February 27, 1896.

THE TEMPERATURE OF THE EARTH'S CRUST.

IN the December number of the *Journal of Science* Prof. Alexander Agassiz gives the temperatures found at different depths in a well-known mine in the Lake Superior region, as follows:

At 105 ft.—59° F.
At 4580 ft.—79° F.

Or an increase of temperature of 1° F. for each 223.7 ft.

With this he compares Lord Kelvin's figures of 1° in every 51 ft; also the figures obtained in the St. Gothard tunnel, showing a rise of 1° for every 50 ft.

The Lake Superior figures would make the solid crust of the earth nearly 90 miles in thickness, instead of Lord Kelvin's deduction of twenty miles.

Now I wish to suggest, as a tenable hypothesis, that the Lake Superior district having been far in the heart of the ice cap of the glacial period, the refrigeration of the crust of the earth penetrated to so great a depth that its effects *still linger*.

Take, for example, the 100° C. line, which normally is 9,000 feet below the surface. During the many thousand years of the ice cap this may have been forced downwards to a depth of, say, 40,000 ft. Since the removal of the ice, during, say, 7,000 years, the internal heat has been slowly rising towards the surface. But it has not yet had time to regain its former levels of temperature.

It would be interesting to ascertain what are the rates of increase of temperature now under regions where the subsoil is permanently frozen, as in the tundras of Siberia and Alaska.

It does not seem clear to me that the earth's crust necessarily became greatly thickened in the Superior region. The refrigeration need not have penetrated deeply enough for such an effect.

SERENO E. BISHOP.

HONOLULU, January 24, 1896.

THE X-RAYS.

SHORTLY after mailing my note of last week I took a photograph by means of the X-rays, using a Crookes' tube connected with an induction coil actuated by a make and break current, and therefore giving the electrodes a fixed polarity.

The photograph shows only one electrode which, from the manner in which the tube was connected, was the cathode, thus confirming the views expressed in my previous letter.

RALPH R. LAWRENCE.

BOSTON, March 5, 1896.

THE INSTINCT OF PECKING.

IN discussing Prof. Morgan's lecture on instinct it has several times been stated that chickens pecked instinctively, but had to be taught to drink. There was a note in *Nature* last year, concerning some species of Asiatic pheasants—it may possibly have been the Jungle Fowl—to the effect that the young did not

and the descriptions are almost entirely independent of each other without definite comparisons.

The third part of the work (184 pp.) is given to his subject proper; it is somewhat unequal in character, being much more detailed and careful in the earlier portion than in the later. Here, too, one looks in vain for comparisons or for any definite reasons for the inclusion of some of the insects in the groups in which they are placed, by references to the earlier portion of his work. The classification is entirely novel and bears little relation to that employed by the present writer, which is an extension of that of Dohrn and Goldenberg. This is not the place for a discussion of the relative merits of the two, which may be left to the impartial student of the future; but in giving up the term Palæodictyoptera for the bulk of paleozoic insects, as indicating the far greater affiliation of insects in paleozoic time than subsequently, Brongniart overlooks the fact that while his discoveries show a wider diversity of forms among paleozoic insects and more definite points of relationship between them and and later types than we have ever had before, they but emphasize and further illustrate the reasons for which the name was proposed. General statements previously made regarding paleozoic insects as a whole are in no way weakened by this great extension of the field, and this renders the importance of these generalizations even greater and their validity surer than before.

The work is most luxuriously issued and the plates all that could be desired, excepting that many of those illustrated by heliogravure (in the most artistic manner, indeed) need to be supplemented by drawings showing the precise origin of each of the veins; these are often obscure in the best photographic picture, since they very often cannot all be seen in any single view, or their contrast to the stone is insufficient for clear results. Why the title page should bear the date 1893 is difficult to understand, for the second signature (p. 12) contains a long extract first published in America in February, 1894, and the earliest copies of the work only reached this country in June, 1895. Except in the separate 'Explanation of the Plates' in the atlas, no reference to the figures occurs in the text, which is a great inconvenience.

SAMUEL H. SCUDDER.

Revision of the Shrews of the American Genera Blarina and Notiosorex. By C. HART MERRIAM, N. Am. Fauna, No. 10, December 31, 1895, pp. 5–34, pll. 1–3.

The Long-tailed Shrews of the Eastern United States. By GERRIT S. MILLER, JR. Ibid., pp. 35–56.

Synopsis of the American Shrews of the Genus Sorex. By C. HART MERRIAM. Ibid., pp. 57–98, pll. 4–12.

The shrews are among the most difficult of mammals to discriminate specifically, owing to their general similarity in color, size and general external appearance. Hence resort must be had to the teeth, which, though minute, often afford trenchant characters. No group of American mammals has hitherto been in a more thoroughly unsatisfactory state, as regards either the number and distribution of the species or the names they should properly bear. Hence the three papers on the American Shrews that constitute No. 10 of 'North American Fauna' are a particularly welcome contribution to the literature of North American mammalogy. Two of these papers are by Dr. C. Hart Merriam and the other is by Gerrit S. Miller, Jr., and jointly they comprise a careful revision of the whole group. The work is based primarily on the collections brought together by Dr. Merriam under the auspices of the United States Department of Agriculture, the only outside material used being mainly the type specimens of previous authors, which in most cases have been accessible to the authors of the papers under notice.

Formerly shrews were rare in collections; generally they were so difficult to obtain that only chance specimens were secured. That such is no longer the case is evident from the large number of specimens now accessible for study in most large collections of mammals, very successful methods of trapping these obscure and mainly nocturnal animals having been discovered within comparatively recent years. Thus the Department of Agriculture collection alone numbers upwards of 2,000 specimens, brought together largely within the last six or eight years.

peck instinctively and did not offer to take food spread before them. The natives seemed well aware of this peculiarity, and in the particular instance recorded a native induced the young birds to peck by tapping on the ground with a pencil near the food. They seemed attracted by the sound and movement, and were thus induced to peck at the food. F. A. LUCAS.

SCIENTIFIC LITERATURE.

BRONGNIART'S PALEOZOIC INSECTS.

Recherches pour servir a l'histoire des Insectes fossilesdes temps primaires, précédées d'une étude sur la nervation des ailes des Insectes. Saint Etienne, 1893. 2 v. 4°. Text, 493 pp.; Atlas, 44 pp., 37 folding plates.

These volumes, which are primarily devoted to the carboniferous insects of Commentry, France, form the most important work that has ever been published on paleozoic insects. Our knowledge of the older hexapods has heretofore been obtained piecemeal, and generally by exceedingly fragmentary researches; while here we are introduced at once to a wealth of material equalling, if it does not surpass, all previous knowledge of paleozoic insects. Mr. Brongniart had indeed published a few of his interesting finds in previous minor papers and had given also a summary account of the Commentry fauna in a brochure in 1885; but as the latter contained almost no details, and was merely a sketch of his classification (here modified in a few particulars), it had slight value except as a forecast of what is now realized.

Cockroaches form in all Carboniferous deposits the major part of the insect remains, and many hundreds of specimens have been obtained at Commentry. Leaving these out of account because reserved by the author for future publication (a few figures only without descriptions being given), the fauna of Commentry consists, according to Brongniart, of Neuroptera, Orthoptera and Homoptera; these he divides into 12 families or larger groups, ten of which are regarded as extinct, and they include 48 genera and 97 species, a number of species just about double that of the previously known European Carboniferous hexapods, exclusive of course of cockroaches.

The variety, novelty and striking character of the forms revealed is as interesting as their number. No one of them, indeed, can be regarded as extraordinary as Eugereon; but we are introduced to long-winged giants regarded by Brongniart as the precursors of the Odonata, but which in spread of wings make our largest dragon-flies appear as pigmies; one, Meganeura, has a spread of considerably more than two feet, and one specimen of this, which I have had the good fortune to see, is so well preserved that four nearly perfect and fully expanded wings are in place attached to the thorax; others have saltatorial hind legs as fully developed as in our existing Locustarians, but with very different wing neuration. Thyspanura (before known fossil only from the Tertiary) are indicated—unfortunately not figured—which have but a single caudal seta; more than fifty specimens of this have been unearthed. Insects are found with a broad lobate expansion on either side of the prothorax, recalling some living Mantidæ (Chœradodis, etc.), but which, being filled with apparent nervures, Brongniart regards with too great confidence as prothoracic wings. Others, and these include a variety of types, have lobate appendages at the sides of all the abdominal segments, like the branchial gills of the larvae of some existing Neuroptera, persistent through life in Pteronarcys. There are also gigantic Mayflies, and Neuroptera of large size with caudal setæ more than six inches long. And, finally, we may mention undoubted cockroaches which show a straight, slender, Locustarian-like ovipositor half as long as the abdomen, an additional and striking difference to distinguish them from modern cockroaches.

Brongniart begins his work with a somewhat detailed historical review of discoveries in the field of paleozoic insects, with an appended bibliography, and follows it by an extended study of the neuration of existing Neuroptera, Orthoptera and Fulgoridæ (180 pp.), as a basis for his attempt to classify the Carboniferous forms; 12 of the plates are also given to the illustration of the wings of modern insects. In this study he follows with some modifications the guidance of Redtenbacher, apparently unaware of some later studies on the subject,

along the principal mountain ranges. The long-tailed shrews in general prefer forested or semi-wooded regions, and a rather northern or alpine habitat; they are hence not generally dispersed south of the northern parts of the United States; farther southward and in the drier portions of the continent they are limited to mountainous districts.

This admirable series of papers is illustrated by twelve plates and some additional cuts in the text giving carefully-drawn figures of the skulls and dental characters of most of the species. Fauna No. 10 thus marks an epoch in the history of this hitherto little-known and difficult group of American mammals.

J. A. A.

Indianische Sagen von der nordpacifischen Küste Amerikas. FRANZ BOAS. Berlin, A. Asher & Co. 1895. 8vo., pp. 363.

This is, undoubtedly, the most comprehensive collection of northwestern Indian myths now in existence and, considering the length of time, the hardships and privations experienced in obtaining them, and the large number of tribes that had to be visited, is a work unique of its kind. Boas had published these myths previously in the 'Transactions of the Berlin Society of Anthropology,' and this explains the fact that they are worded in German and not in English. Most of the stories that were obtained from full-blood Indians in their vernacular had to be translated into Chinook Jargon before they were rendered in German.

Dr. Boas begins with the myths, legends and traditions of the numerous Selish tribes of British Columbia, then presents what he obtained on Vancouver Island and the mainland opposite, and terminates the volume with the tales from the Haida on Queen Charlotte Islands and the Tlingit of southeastern Alaska. The stories have the most varied contents: Origin of the deities and powers ruling the universe and the earth, creation of sun, moon and stars, origin of the elements and seasons, of the tribes of men, animals and plants, of the rocks and islands. Men and women often originate from animals, especially from fish, and the number and variety of the 'fishy' progenitors is so great that no other but a fisher race could have produced a similar folklore. The making of the sun is mostly represented as a liberation of it from a box or inclosure which held it in captivity, and the liberator is the raven, who in his bold flight cuts through the dense cloudiness enveloping the ocean and the seashore or permits it to ascend again to the sky, after night had imprisoned it for a long while. The raven also provides the organisms, when lifeless still, with souls, and is regarded as the animating principle in nature. In the myths of the Eastern tribes the raven is of great significance, being the presager of calamities and death.

The most painstaking portion of Boas' work lies in the appendix from pages 329 to 363, where in a statistical essay the attempt is made to trace one and the same myth through various parts of North America. There are, *e. g.*, nineteen myths in the Northwest found similar to Micmac, eleven to Ponka, twenty-five to Athapaskan — even among the Aino of north Japan elements were discovered comparable to those of the northwest coast. To follow up all these details in Boas' volume, is of the highest interest; the number of linguistic families to which the legends belong are five in number (see Table, p. 329), Selish, Wakash (or Nutka), Tsimsián, Haida and Tlingit—the first and the second of these showing a large number of dialectic sub-divisions.

As a fair instance of the mythic imagery which forms the make-up of the northwestern religions, we may present the world's creation as related by the Tsimsián Indians on Skeena river and the coast of the mainland. They assume that the earth is level and disk-shaped, resting upon a pillar which is held upright by an old woman. Any movement of the old woman causes an earthquake, but the hillocks and sinuosities on the earth's surface were produced by a flood, which scattered all the human beings over the most distant parts of the earth to people them. Whoever wants to visit the sky has to pass through the moon's house, and its headman is called 'Disease.' The west side of the moon's house is guarded by a number of mischievous dwarfs, who are hermaphrodites and likely to attack and kill visitors. When Gamdigyētlnē-eq started to reach the sky, his

The North American species of shrews fall rather naturally into two principal groups, which in popular language are known as the short-tailed shrews and the long-tailed-shrews. The former, comprising the genera *Blarina* and *Notiosorex*, are strictly North American; the latter, referable to *Sorex* proper (with, however, several subgenera), belong to a genus widely dispersed over the northern hemisphere. Of the short-tailed shrews, the genus *Notiosorex* comprises, as now known, only a single species, with a range from near the southern border of the United States southward over a large part of Mexico; *Blarina* has a much wider distribution, ranging, in eastern North America, from about the southern border of Canada southward through Mexico to the mountains of Guatemala and Costa Rica, but in the United States is mainly restricted to the region east to the Great Plains. It is divisible into two subgenera—*Blarina* proper, and *Cryptotis*, chiefly in reference to the number of the teeth, which are 32 in the former and 30 in the latter. In general the species of *Blarina* are much the larger, and are more northern in distribution, this group being 'absolutely restricted to the United States,' all of the Mexican and Central American species belonging to the subgenus *Cryptotis*, which in turn is almost unrepresented north of the Carolinian Fauna.

It is a singular fact in the history of the genus *Blarina* that a representative of both of its sections was made known by Say in 1823, from the same locality, namely, from Engineer Cantonment, near the present site of Omaha, Nebraska, and that they were the first forms of the group made known to science. Say named them respectively *Sorex brevicaudus* and *Sorex parvus*. The latter name especially has ever since been a stumbling block in the way of systematists, but, thanks to Dr. Merriam, is so no longer, his large series from the type locality enabling him to define it and establish its relations to the various names given later to shrews from other parts of the country. It thus proves to antedate *cinereus* of Bachman, while several species provisionally separated from it by Baird are now referred to it as synonyms.

Blarina, according to Dr. Merriam, is represented by 20 species and subspecies, of which 6 are from the United States and 14 from Mexico and Central America; all of the latter and two of the United States forms are referred to to the subgenus *Cryptotis*, leaving only 4 for the subgenus *Blarina*. Most of the Central American and some of the Mexican species are more or less isolated mountain forms, modified from a few formerly more widely dispersed types. Of the 12 new forms here described, 9 are from Mexico, 2 from Florida and 1 from Dismal Swamp, Virginia.

Mr. Miller's paper relates to the long-tailed shrews of the eastern United States, and admirably clears the way for Dr. Merriam's immediately following general synopsis of American species of the genus *Sorex*. At the outset Mr. Miller attacks sundry vexed questions of synonymy resulting from the description of three species of this group by Dr. Richardson, nearly seventy years ago. Fortunately Richardson's types are still extant in the British Museum, and Mr. Miller has recently had, through the kindness of Mr. Oldfield Thomas, the Curator of the Department of Mammals in the British Museum, opportunity to carefully study these invaluable types. As a result Richardson's names may now be considered as properly allocated, and we can with some confidence assign names to our shrews; for until Richardson's names were settled many later names could only be applied tentatively. Mr. Miller treats at length of 7 species, 1 of which is described as new.

Dr. Merriam, in his 'Synopsis of the American Shrews of the genus Sorex,' recognizes 42 species and subspecies, of which 21, or just one-half, are described as new in the present paper. Of this number 34 are referred to *Sorex* proper, 1 to the subgenus *Microsorex*, 4 to the subgenus *Neosorex*, and 3 to the subgenus *Atophyrax*. The shrews of the subgenus *Sorex* range from the Arctic Circle southward over the continent-at-large, or such parts of it as are congenial to their peculiar needs, to the mountains of Guatemala; *Atophyrax* is restricted to the northwest coast region, ranging from western British Columbia to California; *Microsorex* and *Neosorex* occupy a middle transcontinental belt near the northern boundary of the United States, *Neosorex*, however, extending farther southward

friends tried to dissuade him from making the attempt. He told them, "When I get up there you will see that the sun is stopping in its course." He shot an arrow into the blue sky, saw it fly and it stuck fast in the firmament. Another arrow he sent into the notch of the first, another one into the notch of the second and thus was formed a long chain of arrows solid enough for him to climb up. His bow served him to fill a gap in the aërial road. Reaching the moon's house, he was not molested by the dwarfs, but well received by the chief of the moon's dwelling, who washed and cleaned him thoroughly and gave him moral advice what to do after his return to the earth. A board was then removed and Gamdigyētlnē-eq could see the whole earth extended below him as a cyclorama, he then descended again on the arrow-ladder, which fell to pieces after the descent was accomplished and the upholding bow removed from the base.

Boas' book forms an interesting parallel to his 'Chinook Texts' previously reviewed in SCIENCE, but differs from it by the absence of aboriginal Indian texts.

Names and their Histories, alphabetically arranged as a handbook of historical geography and topographical nomenclature. By ISAAC TAYLOR, M. A., Canon of York. London, Rovington, Percival & Co., 34 King St. 1896. pp. 392. 12mo.

To collect the geographic terms which serve to compose a country's local names, and then follow these terms through their compounds as we find them used in the toponymy of a given country, is a method not often followed as yet. Isaac Taylor, M. A., in his '*Names and their Histories*,' has given full swing to this synthetic method in the appendices, and, we must say, with laudable industry and good success. He presents his interesting information not in the form of dry sentences and axiomatic paragraphs, but in the didactic shape of lectures, which do not show any purpose of cramming the listener's brain with erudition and quotations derived from documents one thousand years old. Taylor's easy, unobtrusive prose conveys to the public only what is necessary to know, by giving the earlier historic forms of the local names and from them deducting their signification. The treatise on nomenclature is subdivided in seven chapters, pages 303 to 390, and contains the following items: Indian nomenclature (of East India), Turkish nomenclature, Magyar names, Slavonic nomenclature, French village names, German nomenclature, English village names.

When the student of geography has passed through these propædeutics and become acquainted with the elements of topography in every group of dialects, he finds it many times easier than before to retain so many foreign appellations, often unwieldy and jaw-breaking, because their meaning is now familiar to him. Of the Turkish names the majority are of a vocalic utterance and well sounding, a great help to memory. Thus Buyuk-dere is the 'great valley;' Tash-bunar, the 'stone-well; Bunar-bashi, the 'head of the well' (or 'spring'); Kara Dagh, the 'black mountain;' Mustagh, the 'ice mountain;' Daghestan, the 'mountainous land;' Kara-kum, 'black sand;' Yildiz, the 'northern' (palace); Yeni-bazar, the 'new market.' The names of the seven territories have been studied for many years back by linguists, and Taylor having made use of the writings of his predecessors, can be relied on.

The first part of the volume gives in 302 pages a large number of geographic names from all parts of the globe in alphabetic sequence, each with its historic and linguistic illustrations. Here also Taylor strives to be on a level with the popular understanding and avoids long arguments, wherever these would lead him into dry erudition and scholarly distinctions. Many names are referred to historically, but their derivation is not given because it could not be given with safety; of others the derivation is given as 'probable' only, as of Nazareth, which is supposed to mean a 'watch-tower,' and of Cuba, said to mean 'middle province.' Of a large number the signification is certain, as Damascus 'the place of industry,' Dundas, 'southern fort,' from Gaelic dun-deas; Zimbabwe the 'great kraal,' Sligo called after 'shells found there in heaps,' Lampedusa, 'oyster bank,' Liverpool, a pool where a waterfowl, called 'liver, lever' was found. Seville is Phœnician and means 'plain, lowland,' Marsala the 'port or harbor of Ali." Among those

names which Taylor has explained erroneously we notice Arkansas, Arawak and Tallahassee.

A. S. G.

The Sun. By C. A. YOUNG. New and revised edition. New York, D. Appleton & Co.

The revised and slightly enlarged edition of Prof. Young's '*Sun*' will be read by all with great interest. The first edition of this justly popular work appeared in 1881. Since that time many advances have been made in our knowledge of the sun; new methods of observation have been developed. Prof. Young tried to keep pace with this progress by the addition of notes and appendices in the various editions that have appeared during the interval. He now finds, however, that such expedients are inadequate, and he has, therefore, revised the work and made it representative of the science of to-day.

In general form and appearance the book remains the same as in the first edition. There are, however, a number of new cuts, and the various subjects, treated of in a single chapter, are more clearly separated. Many 'headlings' are introduced into the text, thus greatly aiding a clear understanding of the subject-matter.

Among the most prominent features of the new edition we note the introduction of the latest work on the solar parallax. Gill's methods and results are most carefully treated. Again the great advance in solar spectroscopy is represented by the work of Rowland; the photography of the prominence by that of Hale; the identification of helium by Ramsey. The progress made in the spectroscopic study of the sun is most readily brought out by a comparison of our present knowledge with that of 1881. In the first editions of his work, Prof. Young mentions twenty-one elements as known to exist in the sun. In all of these 860 lines had been identified. Prof. Rowland has now tried sixty elements; thirty-six of which he finds in the sun; sixteen he does not find there and the remaining eight are doubtful. Of one element alone, iron, he has identified more than 2000 lines; more than twice as many as were known in all the elements fifteen years ago.

A careful comparison of the last chapters, the summaries, of the two editions leaves us with a feeling of disappointment, of expectation unfulfilled. Our advance in the knowledge of solar physics has not been so rapid as we fondly imagined. During the last decade and a-half no new great principle, no law, has been discovered. We have improved our methods of observation; we have collected more data; but we know little more of the actual condition of the sun itself than we did in 1881. The first edition of Professor Young's book ends with a statement of the four most important and fundamental problems of solar physics which were at that time pressing for solution. Fifteen years have since elapsed and these four problems are still unsolved, are still pressing for solution.

C. L. P.

Elements of Modern Chemistry. By CHARLES ADOLPHE WURTZ. Fifth American Edition. Revised and enlarged by Wm. H. Greene, M. D., and Harry F. Keller, Ph. D. 12 mo. Pp. 788. Philadelphia, J. B. Lippincott & Co. 1895.

The appearance of the fifth revised and enlarged edition of the translation of this well-known work may be taken as evidence that many have found it useful. The writer believes, however, that a better *elementary* treatise might have been made, if the translators had followed less closely the plan of the original. The introduction is clear and satisfactory. In the next twenty-seven pages we find a discussion of the laws of definite and multiple proportions, equivalents, the laws of Gay-Lussac, Ampère and Avogadro, the atomic theory, the laws of isomorphism and specific heats, nomenclature * * * * * oxygen acids, metallic hydroxides, oxygen salts, nomenclature of non-oxygenized compounds, alloys and amalgams. The study of hydrogen and the other elements is then begun. It needs no argument to prove that this order of subjects is not elementary.

The succession of topics in the study of the compounds of carbon is also unsatisfactory. The order is the following: constitution of organic compounds, formation of hydrocarbons * * * * * monatomic radicals and polyatomic radicals, including general remarks

about diatomic alcohols, acids and ammonias. * * * * * *

The substances first studied are cyanogen, the ferrocyanides, the sulphocyanides, the cyanamides * * * * * urea and some of its compounds. Having mastered these simple subjects, the student is ready for methane and its derivatives. About one-half of the volume is given to the compounds of carbon. The facts are clearly presented, a good selection of compounds has been made, and recent work and theories receive due attention.

The same good judgment has been shownin discussing the other elements and their compounds. A more careful revision of the text would have removed some inaccurate statements. The synthesis of oxalic acid in 1868 can no longer be called recent, nor is it true, as stated on page 236, that nitrogen forms only one compound with hydrogen.

The use of such trivial names as potassa, caustic potassa, soda, gelatinous alumina and others is often exasperating and sometimes leads to incorrect statements. Soda is defined as sodium carbonate, but on page 353 we are told that soda produces, in salts of lead, a precipitate that is soluble in an excess of the reagent. With the general correctness and clearness of statement no fault can be found, and, as an elementary book of reference, this new edition should win new friends.

L. B. HALL.

Principles of Metallurgy. By ARTHUR H. HIORNS. Macmillian & Co., New York. 1895. 12mo., 388 pp., 144 illustrations, cloth binding. Typography and paper of good quality.

It was the authors intention to prepare for those who do not have ready access to the journals of scientific and industrial societies an abridged account of the modern methods of extracting metals from their ores. An object worthy of attainment but in this instance not crowned with success.

The arrangement of the work is as follows: The physical and chemical properties of the metals and their alloys occupy the opening chapters, after which several chapters are devoted to general metallurgy, discussing furnaces, fluxes and fuels. Iron and steel occupy the greater part of the work, followed by chapters on silver, gold, lead, copper, zinc, tin, aluminum, mercury, antimony and bismuth. While each division of the subject contains much of value, the work is to be criticised from the fact that much of the greater value is omitted. By greater value is meant modern practice. There is not a chapter that could not be improved in this respect.

Metallurgy has been defined as the 'art of making money,' and consequently is an eminently practical subject. A treatise therefore should be devoted mainly to modern methods, subordinating historical descriptions and data, a plan quite the reverse of that given by Mr. Hiorns.

Metallurgical processes are of such rapid development that characteristic factors of any one time often become obsolete in a decade, and a work bearing the date of 1895 should present the methods brought up to at least within a few years. The present work quite fails in this respect also. Many errors have been perpetuated from previous works, and a number of illustrations are given of furnaces which have not been used for twenty years and more. American practice is painfully weak, and since we are the greatest individual producer of silver, gold, lead, iron, copper, zinc and mercury, this criticism is of great weight. Some glaring errors in this respect are as follows:

Under blast furnace practice for pig iron the furnaces quoted as embodying modern ideas are not water-cooled and they have exterior fore hearths. In view of the magnificent practice at the Edgar Thompson works where, two years ago a single furnace produced over six hundred tons of cast iron in twenty-four hours, the type of furnace as given by Mr. Hiorns is decidedly ancient.

Under the metallurgy of lead the shaft furnaces given are all of the old type; not one of them is water-cooled. Under zinc the English method is quoted as in use, although Dr. Percy remarked in a lecture that years ago he sought for evidence of this process, but failed to find even the ruins of the furnace foundations. Under steel the American modifications of rapid blowing and low silicon irons are entirely ignored, etc.

As an elementary treatise suitable for students of tender years this work presents the English practice in a general way with sufficient thoroughness to afford a popular understanding of the subject.

American practice is so lamentably weak that the work is of little practical value to our students. With extensive cutting and the addition of much new material it might be transformed into a work of value, but, as Kipling would say, "that is another story."

J. STRUTHERS.

SOCIETIES AND ACADEMIES.

BIOLOGICAL SOCIETY OF WASHINGTON, 256TH MEETING, FEBRUARY 22.

C. HART MERRIAM spoke of *The American Weasels*, describing at some length the various species, their habitats and relationships.

F. E. L. Beal read a paper on *the Food of the Bluejay*, being the results of the examination of about 300 stomachs of this species collected in every month of the year and fairly representing all parts of the bird's range. The food is found to consist of animal and vegetable matter in the proportion of about one of the former to three of the latter. The animal matter is composed largely of injurious insects. The alleged habits of the jay of eating the eggs and young of other birds is only partially confirmed. Of the whole number of stomachs only two, taken in the breeding season, contained shells of eggs and one the remains of a young bird. One stomach taken in February contained the remains of a bird, and several taken at various times contained shells of eggs, apparently those of domestic fowls. The vegetable food consists principally of grain, mast and fruit. Of the first two mast is the favorite, being the most important element of the yearly diet. Corn is the favorite grain. The fruit consists for the most part of wild species.

David White discussed *the Structure and Relations of Buthograptus, Plumulina and Ptilophyton from the North American Palæozic.* After describing the structure of these genera in detail, the speaker stated that it would seem that all the forms considered may belong to one type of nonvascular, feather-like, or plumose organisms, which consist of a hollow or cellular thin-walled rachis, or axis, destitute of any central strand, forking but seldom in some species, perhaps in all, and possibly divided by transverse septa into cells, though this is not clearly shown in any individual case. To this axis are articulated by round or oval joints, two or more series of more or less elongate, very thin-walled, bladder-like sacs, which, for convenience, are called pinnules. With rare exceptions, these sacs are quite regularly arranged with respect to one another, their parallelism in the impressions giving the feathery appearance to the pinnæ. Similar relations obtain in all the species considered. The pinnules appear to have been eventually deciduous, falling away from the lower portion of the rachis. Although several of the species appear at first glance to very strongly resemble hydroids, the speaker followed Dawson and Lesquereaux in considering these organisms to be vegetable in their nature.

Sylvester D. Judd described *a Peculiar Eye of an Amphipod Crustacean, Byblis serrata.* He said that this crustacean, which belongs to the family *Gammaridæ*, has totally different eyes from *Gammarus*. This peculiar eye of *Byblis* reminds one of the vertebrate eye, for both agree in having a biconvex lens and a fluid filled space with the retina below. A section through the chief axes of the eye of *Byblis* would first show a large lens, which has been secreted in concentric shells by a thickened layer of lentigen, which is on either side continuous with the thinner hypodermis, which is gorged with scarlet pigment that envelopes the eye like a cornucopia, thus shutting out all rays that might reach the retina without first passing through the lens. Under the lentigen is a crescent-shaped humor space. Below and proximal to this space is a layer of columnar cells, which is continuous on either side with the hypodermis. This layer of cells has secreted on its outer boundary, which borders on the space, a strong cuticula. Just proximal to this layer of cells, which has secreted the cuticula, are the omatidia (which of course lack the corneal cuticula). The most distal element of an omatidium is a granular columnar body (cell product). Below and proximal to this columnar

body, the remainder of the omatidium with its refractive cone and retinula is practically identical with the omatidium of *Gammarus*, minus, of course, the corneal cuticula. For in the retinula of both crustaceans there are five retinal cells with pigment, and four rhabdomeres. There are two of these peculiar crater-like eyes that project from either side of the cephalon of *Byblis serrata*.

Vernon Bailey exhibited *Two Mammals New to the Vicinity of Washington*, being *Sorex personatus* and *Synaptomys Cooperi*. In 1888 skulls of these mammals were found in pellets ejected by the Long-eared Owl, but until the capture of the specimens shown, which were taken at Hyattsville it had not been definitely proved that these species were found in the immediate vicinity.

F. A. Lucas,
Secretary.

GEOLOGICAL SOCIETY OF WASHINGTON.

At the meeting of the Geological Society of Washington (D. C.), held on February 26, 1896, the following communications were presented:

Mr. W J McGee exhibited the geologic map of the State of New York recently printed by the United States Geological Survey in coöperation with Prof. Hall, State Geologist. He stated that the map had been in preparation for the last ten years and its preliminary draft was a compilation by Prof. Hall and himself in greater part from old data. Finding that these were very incomplete and unsatisfactory in many areas, new field work was begun and continued for several years. In the meanwhile a new base was compiled from county maps and other sources. The larger part of the field work was done by Mr. N. H. Darton, of the United States Geological Survey, who mapped the geology of nearly the entire area of the Helderberg and associated formations, the faulted area extending along the Mohawk valley and around the southern side of the Adirondacks to Lake George, the Niagara escarpment, the northern and eastern portions of the Catskill Mountains, the Oneonta region, the greater portions of Albany, Ulster, Orange and Rockland counties, and the Juratrias area of New Jersey. Dr. F. J. H. Merrill contributed data for Westchester, Putnam and New York counties, and Prof. J. F. Kemp mapped much of the region lying along the eastern side of the Adirondacks. Data for smaller areas were obtained from published or manuscript maps by Messrs. C. D. Walcott, T. N. Dale, J. H. Clarke, W. M. Davis, W. B. Dwight, Mr. Randall, Prof. Smythe and others. The map was edited by Mr. Willis Bailey.

Notes on the Geology of the Black Hills of Dakota were presented by Mr. N. H. Darton. The region was visited last autumn for a study of the outcrops of the Dakota sandstones and the associated formations, in connection with an investigation for the United States Geological Survey of the artesian waters of the Dakotas. There was first described a detailed section which had been carefully measured from the base of the Potsdam to the White River Miocene formation, along a line passing through Rapid City to the Bad Lands. The thickness of the upper Cretaceous members in this section have since been most satisfactorily verified by the deep well-boring on the Rosebud Indian Reservation. The salient features of the general stratigraphy were pointed out and the alleged unconformities in the Juratrias formations were discussed. Attention was called to a well-defined peneplain now represented by the eastern 'hog back' foothills of which the very even crest lines are at an altitude very nearly 4,000 feet above sea level for over 100 miles. Diagrams were exhibited of a very interesting laccolite west of Tilford, and the structure of the Bear Butte and Warren Peaks eruptive areas were described. Some incidental observations in the nucleal region of the hills brought to light some important details of stratigraphy of the Algonkian beds, and some examples illustrating the development of schistosity in the vicinity both of granite and younger eruptives.

Several miscellaneous specimens were shown, including cone-in-cone structure developed in Pierre clays by the pressure caused by the formation of sideritic concretions; material from sandstone disks in the Bad Lands, having vertical cleavage into thin plates with horizontally corrugated surfaces, and masses of phosphated grains from the Pierre clays, which appear to be of coprolitic character.

In the discussion which followed this paper, Mr. M. R. Campbell alluded to the close similarity between the relations of the even crest lines of the 'hog back' ranges described by Mr. Darton, and the Appalachian ridges, and endorsed the view that they are similarly the remnants of peneplains preserved by the harder rocks.

Mr. F. W. Crosby presented a paper entitled 'The Sea Mills of Cephalonia.' These mills are run by sea water which flows into fissures with considerable velocity. The origin of these fissures and the conditions which enables the sea water to sink into them below the level of the sea have been the subjects of popular speculation for many years, but they appear to have attracted but little attention among geologists. Mr. Crosby then quoted a paper by his son, Prof. W. O. Crosby, in which the mechanism of the phenomena was discussed and a hypothesis offered to account for it.

A paper on the 'Stratigraphy at Slate Springs, California,' by Mr. H. W. Fairbanks, was read by Mr. Lindgren.

W. F. MORSELL.

CHEMICAL SOCIETY OF WASHINGTON.

THE 85th regular meeting, which was also the 12th annual meeting of the Society, was held January 9, 1896. The following were elected to membership: Messrs. E. C. Wilson, E. W. Magruder and C. C. Moore. The publication of Bulletin No. 9, was announced and the following officers were elected: President, E. A. de Schweinitz; Vice-Presidents, W. D. Bigelow, W. G. Brown; Treasurer, W. P. Cutter; Secretary, A. C. Peale; additional members of the Executive Committee, Chas. E. Munroe, F. P. Dewey, V. K. Chesnut, H. N. Stokes.

The first paper read was by Dr. H. W. Wiley, on a 'Steam Jacketed Drying Oven,' and the oven was shown in actual operation. In order to surround the drying space of the oven entirely with steam, the door of the ordinary steam jacketed oven is made with double walls, and the steam from the oven conducted into it from the oven by two metal flexible tubes at the top and bottom of the door, so arranged as not to interfere with its opening. The temperature is regulated by a pressure gauge in which, when a given pressure is reached, the steam cuts off the gas by acting on a column of mercury. When steam is used the temperature can be regulated by setting the gauge to read at any position, to read from the boiling point of water up to 105°. For other higher temperatures other liquids can be used, as alcohol or amyl. alcohol, but ether cannot be safely employed on account of the danger of explosion if there is any leakage.

Dr. Wiley also read a paper on the 'Heat of Bromination in Oils.' The especial difficulty on the process of proposed by Hehner and Mitchell is in handling the liquid bromine in quantities of one cc. at a time. Dr. Wiley found that the process is made practicable by dissolving both the oil or fat and the bromine in chloroform when the solution is easily handled by means of a special pipette. He described the process in detail and said the determinations should be conducted in a room when the temperature is as constant as possible, and the pieces of apparatus should be exposed to the open air for at least half an hour after completing one determination and before beginning another, in order that it may be restored to the standard room temperature. Duplicates usually agree within one or two-tenths of a degree. The ratio of the heat of bromination to the ordinary number must be established for each system of apparatus employed. The process seems to be one of considerable analytical value. For exact scientific purposes calorimetric measurement of the degree of heat produced must be made.

Prof. Chas. E. Munroe made some remarks upon 'The Corrosion of Electric Mains,' and exhibited sections of electric light cables, in which the lead coating had become so corroded that in some places the interior conductor was exposed, while at others the cable was coated with nodular earthy looking masses. The cables were parts of a three-wire system, which carried a direct current of 110 volts on each wire, and which had been laid underground in the upper compartment of the terra cotta conduit. The corroded main was a branch in an alley, while the principal main was in the street and was not attacked. Analysis showed the incrustation to be nitrate,

chloride, carbonate and oxide of lead with water and a trace of organic matter. Surrounding the alley were stables, and in the salts found in the soil produced by the excreta were all the necessary materials and conditions for effecting chemical corrosion *per se* without resorting to any electolytic theory. In the discussion of the paper Dr. Wiley said he thought there might have been a denitrifying process. Prof. Munroe said there had been no submergence of the cable, but that there must have been water passing through the conduit.

A. C. PEALE,
Secretary.

ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA, FEBRUARY 25.

PAPERS under the following titles were presented for publication: 'The Coloring Matter of the Aril of Celastrus scandens,' by Ida A. Keller; 'The Crystallization of Molybdenite,' by Amos P. Brown. The Anthropological Section having precedence, Dr. D. G. Brinton made a communication on the use of the craniofacial line in determining racial and individual characters on the living subject. The relation of the diameters of the cranium, formerly relied on, had been found unsatisfactory. He specially recommended a line closely resembling that suggested by the sculptor, Charles Rochet. It connects the two auditory foramina, forming a slight curve, the superior border of which connects the internal commissures of the eyes. This line, it is claimed, divides the ideal, normal head into two perfectly equal parts, although in nature, of course, this proportion is not maintained, but varies as a racial character and in individuals. The relations of the lines may also indicate the cranial capacity, as the plane of the curve continued posteriorly is approximately the base of the skull. He farther pointed out that the distance between the distal extremities of the curve gives the width of the head and the face, and that a series of curves, described from the fixed points indicated, offers probably the simplest and most accurate method of obtaining significant head-measures on the living subject.

Dr. Harrison Allen commented on the difficulty of obtaining satisfactory cranial measurements and referred to Oldfield Thomas's lines taken from the outer margin of the orbits to determine the projection of the nose. He did not think the true horizontal plane of the skull could be fixed. The so-called Frankfurt plane is the one most commonly accepted.

Dr. Seneca Egbert stated that he had demonstrated the action of the X-rays through plates of platinum from ordinary sun light. Illustrative pictures were exhibited, and the published results of other experiments were discussed.

Prof. Maxwell Sommerville exhibited beautiful specimens of chipped arrow-heads made from common green bottle glass by the natives of northwestern Australia. He also called attention to a stone carved to resemble a miniature grotesque head from the valley of the Delaware opposite Milford, and an object used in phallic worship by the natives of Poonah, India.

Dr. D. G. Brinton called attention to the importance of obtaining systematic data for the study of American anthropology and suggested the wide distribution, under the auspices of the Anthropological Section of the Academy, of circulars of inquiry similar to those in use by the committee appointed by the British Association for the Advancement of Science for the study of the ethnography of Great Britain.

EDW. J. NOLAN,
Recording Secretary.

NEW BOOKS.

Atlas of Nerve Cells. M. ALLEN STARR. New York and London, Columbia College Press, Macmillan & Co. 1896. Pp. x+78 & 51 plates. $10.

Text-Books of General Pathology and Pathological Anatomy. RICHARD THOMA. Translated by ALEXANDER BRUCE. London, Adams and Charles Black. New York, Macmillan & Co. 1896. Pp. xiv+624. $7.00

Electric Wiring. RUSSELL ROBB. New York and London, Macmillan & Co. 1896. Pp. 183. $2.50.

Résultats des examen de dix mulle observations de hernies. PAUL BERGER. Paris, Alcan. 1896. Pp. 206.

Annuaire de l'Observatoire Royal de Belgique. F. FOLIE. Bruxelles. 1896. Pp. 551.